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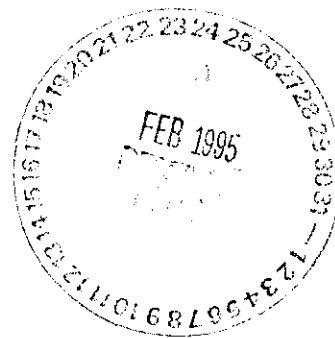
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Draft B

200-UP-1 FY 1995 Characterization Drilling Description of Work

Author
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CONTENTS

1.0	SCOPE OF WORK	1
1.1	PROPOSED ACTIVITIES	1
1.1.1	216-S-7, 216-S-13, 216-S-20, 216-S-25, 216-S-26 Cribs, and 216-S-10D Ditch	1
1.2	GENERAL SITE GEOLOGY AND HYDROLOGY	3
2.0	GENERAL REQUIREMENTS	5
2.1	HEALTH AND SAFETY	5
2.2	PREREQUISITES	5
3.0	FIELD ACTIVITIES	6
3.1	CONTAMINANTS OF CONCERN	6
3.2	SCREENING, BACKGROUND, AND BASELINE ACTIVITIES	6
3.3	GENERAL DRILLING ACTIVITIES	11
3.4	MONITORING WELLS	12
3.4.1	Design Specifications for Monitoring Wells	12
3.4.2	Screen and Filter Pack Selection for Monitoring Wells	13
3.5	AQUIFER TESTING	13
3.6	WATER AND SOIL SAMPLING	13
3.6.1	Water Sampling	13
3.6.2	General Soil Sampling Requirements	13
3.6.3	Soil Sampling	15
4.0	QUALITY ASSURANCE/QUALITY CONTROL REQUIREMENTS	18
5.0	SCHEDULE	19
6.0	AS LOW AS REASONABLY ACHIEVABLE CONSIDERATIONS AND CHANGES TO THE DESCRIPTION OF WORK	19
7.0	REFERENCES	20
ATTACHMENTS:		
1	200-UP-1 DESCRIPTION OF WORK PROJECT CHANGE FORM	23
2	TELECON	25
APPENDICES:		
A	EXCERPTED SECTIONS FROM WORK PLAN	A-1
B	GEOLOGIC SAMPLING	B-1
C	SLUG INTERFERENCE PROCEDURE	C-1

CONTENTS (Continued)

FIGURES:

1. Site Location Map	2
--------------------------------	---

TABLES:

1. Analytical Methods for Target Analytes - Perched Water	7
2. Analytical Methods for Target Analytes - Soils	9
3. Well Construction Parameters 200 West Area, 200-UP-1	12
4. Proposed Sampling Intervals	14
5. Soil Sampling Codes	15
6. Physical Sample Bottle Requirements	17

ACRONYMS

ALARA	as low as reasonably achievable
ASTM	American Society for Testing and Materials
BHI	Bechtel Hanford, Inc.
BWIP	Basalt Waste Isolation Project
CERCLA	<i>Comprehensive Environmental Response, Compensation, and Liability Act of 1980</i>
CLP	Contract Laboratory Program
DOW	description of work
Ecology	Washington State Department of Ecology
EFS	Environmental Field Services
EII	Environmental Investigations Instructions
EPA	U.S. Environmental Protection Agency
FY	fiscal year
GEL	Geotechnical Engineering Laboratory
HEIS	Hanford Environmental Information System
IRM	interim remedial measures
LFI	Limited Field Investigation
p/m	parts per million
RCRA	<i>Resource Conservation and Recovery Act of 1976</i>
RI/FS	Remedial Investigation/Feasibility Study
RWP	radiation work permit
VOC	volatile organic compound
WAC	<i>Washington Administrative Code</i>
WHC	Westinghouse Hanford Company

1.0 SCOPE OF WORK

This description of work (DOW) details the field activities associated with the drilling, soil sampling, and construction of groundwater monitoring wells in the 200-UP-1 Operable Unit (Tasks 2, 3, and 5 in the 200-UP-1 Remedial Investigation/Feasibility Study [RI/FS] Work Plan [DOE-RL 1994]) and will serve as a field guide for those performing the work. It will be used in conjunction with the *Remedial Investigation/Feasibility Study Work Plan for the 200-UP-1 Groundwater Operable Unit Hanford Site, Richland, Washington* (DOE-RL 1994) and the *Environmental Investigation Procedures Manual* (BHI 1994). Groundwater wells are being constructed to characterize the vertical and horizontal extent of limited field investigation (LFI) designated contaminant/plumes and to define aquifer properties such as hydraulic communication between aquifers and hydrostratigraphy. These data will be used to support the preparation of an LFI report. For further discussion of data uses, refer to Section 4 of the Work Plan (DOE-RL 1994). The locations for the proposed groundwater wells are presented in Figure 1. The contaminants of concern for the project are summarized in Section 3.1, "Contaminants of Concern."

1.1 PROPOSED ACTIVITIES

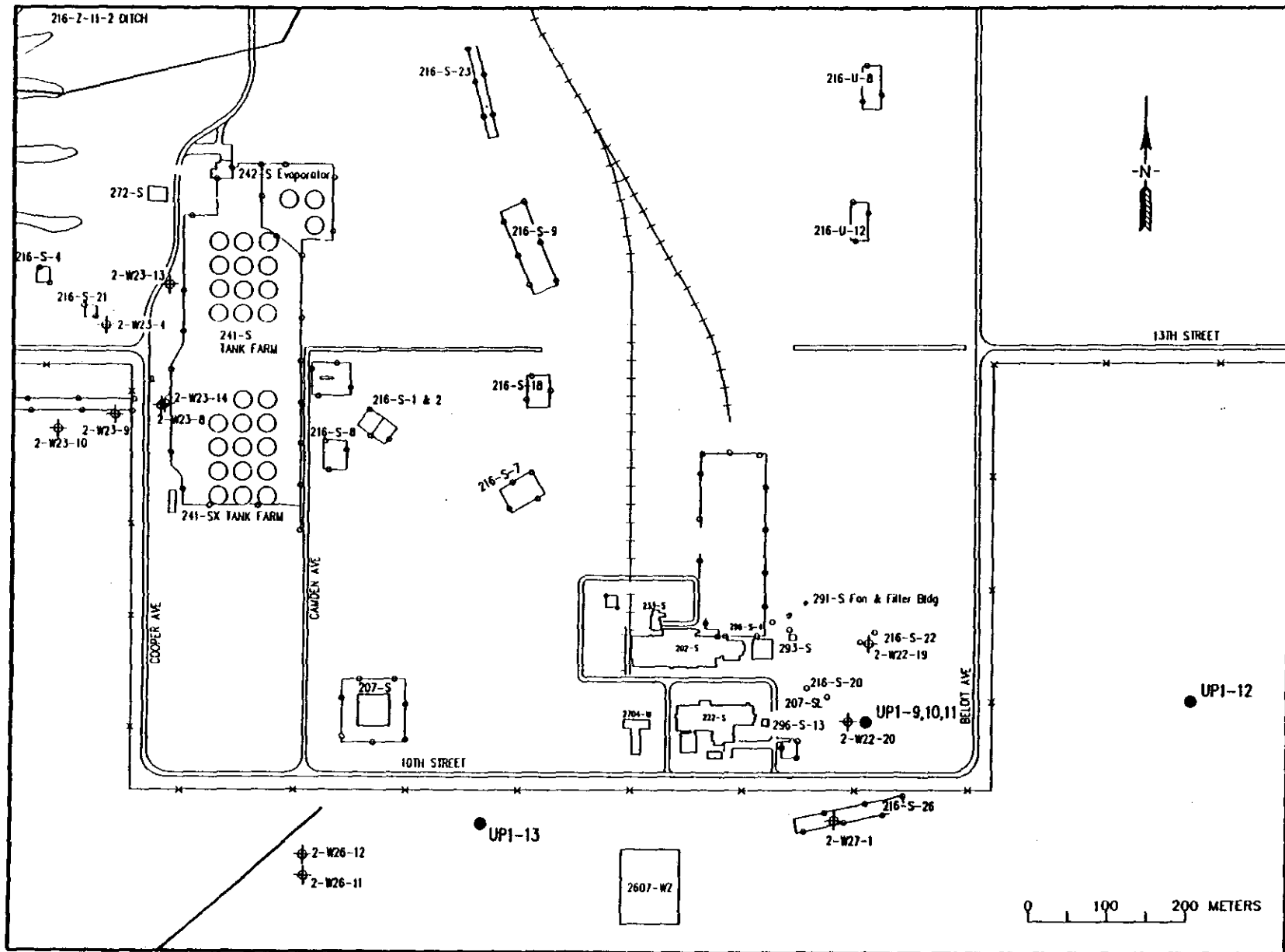
The following sections supply the general criteria and activities for proposed monitoring well installation. Detailed data on waste volumes, contaminants, and system history are contained in the *U-Plant Source Aggregate Area Management Study Report* (DOE-RL 1992) and the *200 West Groundwater Aggregate Area Management Study Report* (DOE-RL 1993). The activities described in this DOW are based on recommendations in the *Remedial Investigation/Feasibility Study Work Plan for the 200-UP-1 Groundwater Operable Unit, Hanford Site, Richland, Washington* (DOE-RL 1994).

The Work Plan (DOE-RL 1994) proposed a total of six wells to support the LFI, including two confined wells (UP1-8 and UP1-11). The primary purpose of the confined wells was to assess the hydraulic gradients between the confined and unconfined aquifers. The installation of well UP1-8 was not proposed in the DOW because the installation of well UP1-11 and the availability of existing well/piezometer facilities are considered to be sufficient to meet the primary data needs.

1.1.1 216-S-7, 216-S-13, 216-S-20, 216-S-25, 216-S-26 Cribs, and 216-S-10D Ditch

Five groundwater monitoring wells will be constructed to better define the horizontal and vertical extent of plumes and hydrogeology in the S-Plant area. All wells will be designed as standard monitoring wells per the *Generic Well Specification*, WHC-S-014 (WHC 1990b), or the equivalent Bechtel Hanford, Inc. (BHI) specification. The plumes or contaminants of concern designated as LFI contaminants in the Work Plan are associated with waste discharges from the S-Plant. Currently the extent of the contaminants is defined by the existing monitoring wells in the S-Plant area, which supply limited definition to the east and the southwest of the area. Vertical characterization of the contaminants is also limited because of the lack of wells that monitor discrete vertical intervals. For more details concerning data quality objectives (DQO), well placement strategy, etc., refer to the Work Plan (DOE-RL 1994).

Figure 1. Site Location Map.



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To better define the horizontal extent of LFI contaminants in the subject area, two wells will be installed in the upper unconfined aquifer. Well UP1-12 will be installed approximately 1,000 ft east of existing well 299-W22-20 and will monitor the extent of contamination believed to originate from the 216-S-20 and 216-S-26 cribs. Well UP1-13 will be installed approximately 2,000 ft southwest of well 299-W22-20 and will monitor the extent of contamination believed to originate from the 216-S-7 and 216-S-13 cribs and 216-S-10D ditch.

To better define the vertical extent of contaminants in the subject area, three wells will be constructed to monitor deeper portions of the unconfined aquifer and the uppermost confined aquifer. Wells UP1-9, UP1-10, and UP1-11 will be constructed as a cluster site to monitor the vertical distribution of contaminants within deeper portions of the unconfined aquifer and to provide vertical hydraulic gradient data between the unconfined and confined aquifer in the vicinity of well 299-W22-20 (downgradient from the 216-S-20 crib).

1.2 GENERAL SITE GEOLOGY AND HYDROLOGY

Suprabasalt sediments underlying the 200-UP-1 area include, from the surface downward, Holocene eolian sands, the Hanford formation, the early Palouse/Plio-Pleistocene interval, and the Ringold formation. These strata overlie basalts of the Columbia River Basalt Group. The geology of this area is outlined in the following text. Stratigraphic columns are presented in Appendix B. More detailed discussions of Hanford Site and 200 West Area geology can be found in Myers et al. (1979), Tallman et al. (1979, 1981), Reidel and Fecht (1981), DOE (1988), Delaney et al. (1991), Lindsey (1991), Lindsey et al. (1992), and Connelly et al. (1992).

Holocene-aged deposits form the uppermost unit in the area. These deposits consist of eolian silt and sand that forms a thin (< 10 ft), discontinuous sheet across the site.

The uppermost laterally continuous unit in the area is the Hanford formation. The Hanford formation consists of an upper gravelly interval (25 to 100 ft thick) and a lower, finer interval (10 to 100 ft thick). Stratified, open-framework, and largely uncemented granule-to-cobble gravel deposits typical of the gravel-dominated facies (Lindsey et al. 1992) dominate the upper interval. Localized interbeds of the sand- and silt-dominated facies also may be present in the upper interval. Interstratified strata typical of both the sand-dominated and silt-dominated facies form the Touchet-like bed strata of the lower interval. Silt-rich horizons within the lower interval may be well compacted and partially cemented by calcium carbonate. The lower interval also may contain pebbly horizons up to 5 ft thick. Examination of geologic logs from recently drilled (FY 1993) and closely spaced boreholes in the U-14 ditch area and outcrops of analogous strata (at the White Bluffs, several miles northeast of the operable unit) indicate that individual beds may be very discontinuous, commonly pinching out over a distance of a few hundred feet.

The 1- to 25-ft thick Plio-Pleistocene interval consists of locally derived basaltic detritus, deposits reworked from the Ringold formation, and calcium carbonate-rich paleosols. In the central 200-UP-2 area, the interval appears to be dominated by a mix of silt, sand, and gravel containing thin (< 1-in. thick), calcium carbonate horizons, (caliche) coated clasts, and nodules. Examination of borehole geologic logs, split-tube samples, and Basalt Waste Isolation Project (BWIP) cores suggests that the well-cemented carbonate horizons may be discontinuous and highly fractured.

Recent drilling at the U-14 ditch revealed that the lower interval of the Hanford formation and Plio-Pleistocene carbonate horizons are commonly cross-cut by clastic dikes. Clastic dikes, described by Black (1979), most commonly consist of vertical to subvertical layers of silt and sand that cut across bedding planes. The presence of these dikes coupled with the abundance of laterally discontinuous beds in the Plio-Pleistocene and lower Hanford intervals suggests that perched groundwater intervals may be of limited lateral extent. Again, recent observations in the area of the U-14 ditch indicate this is the case; in boreholes spaced less than 300 ft apart perched water was never encountered twice in the same horizon. In addition, where perched water was reported, it was found above fine-grained zones within the lower Hanford interval (Touchet-like beds), and not on carbonate beds in the Plio-Pleistocene. The lack of laterally extensive perched waters is inferred to be directly related to the absence of laterally extensive fine-grained horizons within the Hanford formation, the absence of laterally extensive and unfractured calcium carbonate horizons in the Plio-Pleistocene, and the presence of clastic dikes that potentially acted as vertical pathways for the downward movement of water within the vadose zone. The presence of the perching intervals as described above will define the methods for drilling boreholes as described in Section 3.3, "General Drilling Activities."

Ringold formation strata above the water table in the central 200-UP-1 area consist largely of the partially cemented fluvial gravels and minor sands and silts of Unit E (Appendix B). Interbedded fluvial sands and paleosols of the Ringold formation upper unit also may be present in the area of the U-17 crib. Cemented zones and silt layers within these units may cause perched conditions. Based on existing data, it is not clear if these horizons are continuous or discontinuous.

The saturated thickness of Unit E beneath the 200-UP-1 area, which is generally considered an unconfined aquifer, ranges from approximately 200 ft (61 m) in the northwest and west to 155 ft (47 m) in the east. Partially cemented fluvial gravels containing minor intercalated sandy and silty zones characterize the saturated part of Unit E. These sediment types are essentially the same as those found in the unit above the water table. Well-indurated and silt-rich zones that generate locally confined aquifer conditions have been occasionally encountered in Unit E in the northern 200 West Area and in Unit E east of the 200-UP-1 Operable Unit. The presence of cemented zones in boreholes DH-7 (W19-10), DH-12 (W14-7), and DH-13A (W14-8A) suggests that similar conditions may occur in the southern half of the 200 West Area.

Silt-rich paleosols and lacustrine deposits of the lower mud unit underlie Ringold Unit E throughout the 200-UP-1 area. The top of the lower mud unit ranges from approximately 300 ft (91.5 m) above sea level in the eastern part of the area to 250 ft (76 m) in the west. Localized highs (near W18-22) and lows (near W19-10) may be present on this surface. The lower mud unit forms the base of the unconfined aquifer zone in the 200 West Area. No pathways through the lower mud unit into underlying units (such as erosional windows) are known to occur in the southern 200 West Area. Therefore, all water-bearing geologic units occurring below the lower mud unit in the 200-UP-1 area are considered confined aquifers.

Fluvial gravels similar to those that form Unit E comprise the lowest unit in the Ringold formation, Unit A. Intercalated fluvial sand and mud-rich zones can be found in Unit A. Unit A is present beneath the entire site and directly overlies basalt. This unit forms the lowest zone in the suprabasalt aquifer system beneath the 200 West Area.

2.0 GENERAL REQUIREMENTS

2.1 HEALTH AND SAFETY

All field personnel working to this DOW will have completed the 40-Hour Hazardous Waste Site Worker Training Program and will perform all work in accordance with the following:

- BHI-EE-01, *Environmental Investigations Procedures* (BHI 1994)
- WHC-CM-1-6, *Radiological Control Manual* (WHC 1993)
- WHC-CM-4-3, *Industrial Safety Manual*, Vol. 1 through 4 (WHC 1987)
- WHC-CM-4-11, *ALARA Program* (WHC 1988a)
- WHC-CM-7-5, *Environmental Compliance Manual* (WHC 1988b)
- WHC-EP-0383, *Environmental Engineering, Technology, and Permitting Function Quality Assurance Program Plan* (WHC 1990a)
- WHC-IP-0692, *Health Physics Procedures Manual* (WHC 1991)
- Site-specific health and safety plan/radiation work permits/job safety analysis.

2.2 PREREQUISITES

The requirements and procedures applicable to the 200-UP-1 Operable Unit field activities are specified in the *Environmental Investigations Procedures* (BHI 1994). Applicable Environmental Investigations Instructions (EII) include the following:

- EII 1.1, "Hazardous Waste Site Entry Requirements"
- EII 1.5, "Field Logbooks"
- EII 1.13, "Environmental Readiness Review"
- EII 2.1, "Preparation of Site-Specific Health and Safety Plans"
- EII 3.2, "Calibration and Control of Monitoring Instruments"
- EII 3.4, "Field Screening"
- EII 4.3, "Control of CERCLA and Other Past-Practice Investigation Derived Waste"
- EII 5.1, "Chain of Custody/Sample Analysis Request"
- EII 5.2, "Soil and Sediment Sampling"
- EII 5.2, Appendix B, "Split-Spoon Sampling"
- EII 5.4, "Field Cleaning and/or Decontamination of Equipment"
- EII 5.5, "Laboratory Cleaning of RCRA/CERCLA Sampling Equipment"
- EII 5.10, "Obtaining Sample Identification Numbers and Accessing HEIS Data"
- EII 5.11, "Sample Packaging and Shipping"
- EII 6.7, "Documentation of Well Drilling and Completion Operations"
- EII 9.1, "Geologic Logging"
- EII 11.1, "Geophysical Logging"

3.0 FIELD ACTIVITIES

The following sections detail the activities to be conducted for the drilling, sampling, analysis, aquifer testing, and construction of groundwater monitoring wells in the 200-UP-1 Operable Unit.

Background information applicable to these activities is presented in DOE-RL (1994), Section 5.1.3, "LFI Field Activities," and its subsections (excerpted and attached as Appendix A to this document). For the locations of these proposed monitoring wells, see Figure 1.

3.1 CONTAMINANTS OF CONCERN

The primary groundwater contaminants of concern associated with this drilling include chromium (VI), carbon tetrachloride, trichloroethylene, dichloroethane, dichloroethene, ^{129}I , ^{90}Sr , ^{99}Tc , and gross alpha/beta. Additional analyses may be performed for other radionuclides, volatile organic compounds (VOC), semivolatile organic compounds, pesticides, common ions, and metals to improve the operable unit conceptual model. These additional analytes are presented in more detail in Table 1 and Table 2.

3.2 SCREENING, BACKGROUND, AND BASELINE ACTIVITIES

Samples and cuttings will be field screened for radionuclides and for carbon tetrachloride (the indicator species for organics at the site), as specified in the Waste Control Plan, the Hazardous Waste Operations Permit, and the Radiation Work Permit. Soil screening for carbon tetrachloride will be conducted using a photoionization detector equipped with an 11.7-eV lamp. Radionuclides will be screened by alpha and beta-gamma counting instruments. Field screening will be performed in accordance with EII 3.4, "Field Screening." The action level for radionuclides is twice background, as specified in DOE-RL (1994), and is based on 95% confidence that anthropogenic species are identified. The action level for carbon tetrachloride screening is 5 p/m. All instruments will be used, maintained, and calibrated consistent with EII 3.2, "Calibration and Control of Monitoring Instruments," and EII 3.4, "Field Screening." The field geologist will record screening results on the borehole log (per EII 9.1, "Geologic Logging" [BHI 1994]).

Table 1. Analytical Methods for Target Analytes - Perched Water. (sheet 1 of 2)

Analyte ^a	General Analytical Technique ^b	Water Analysis Method	Container and Volume ^c	Comments
Gross Alpha Gross Beta	Gas proportional	f	d	--
VOCs	GC/MS	CLP-VOAs	Gs 3 x 40 mL	Gs 2 x 40 mL
Semivolatile Organic Contaminants	GC/MS	Semi-Volatile Organic Analysis	aG 3 x 2 L	This analysis has a 7-day hold time prior to extraction, requiring shipment of samples within 3 days of sampling or as soon as possible.
All Identifiable and Quantifiable Isotopes	Gamma Spectrometry	f	d	
Iodine-129 Strontium-90 Technetium-99 ^b	Beta Counting	f	d	
Nitrate Nitrite	Colorimetric	353.2	P/G 300 mL	P/G 500 mL for Weston.
Fluoride	Ion Chromatography	300	300 mL	G 500 mL for Weston.
Americium-241 Curium-244 Neptunium-237 Plutonium-238 Plutonium-239/240 Uranium-234 ^c Uranium-235 ^c Uranium-238 ^c	Alpha Spectrometry	f	d	May also use gamma spectrometry.
Tritium	Scintillation	f	Gs-250 mL	
Arsenic Selenium	Graphite Furnace Atomic Absorption	METALS	e	
Mercury	Cold Vapor Atomic Absorption	METALS	e	
Aluminum Antimony Barium Beryllium Cadmium Calcium Chromium Cobalt Copper Iron Lead Magnesium Manganese Mercury Nickel Potassium Silver Sodium Thallium Vanadium Zinc	ICP Analysis	METALS	e	

Table 1. Analytical Methods for Target Analytes - Perched Water (sheet 2 of 2)

Sample volumes listed in this table are estimated based on contract laboratory requirements as of October 1994. Sampling personnel should follow volume requirements listed in the task-specific Sample Authorization Form.

aG	=	amber Glass
CLP	=	Contract Laboratory Program
G	=	Glass
Gs	=	Glass septum w/zero headspace
ICP	=	inductively coupled plasma
M	=	method modified to include extraction from the solid medium, extraction method is matrix and laboratory-specific
P	=	Plastic
TBD	=	To Be Determined
VOA	=	volatile organic analysis

ASTM (1985), DOE/EML (1990), EPA (1980a, 1980b, 1983, 1984, 1986).

^aIn addition to the analytes listed in this table, there are many progeny isotopes whose concentrations may be derived from known parent concentrations. Radionuclides related to U-238 include Th-230, Bi-210, Bi-214, Po-214, and Po-218. Radionuclides related to U-235 include Th-231, Tl-207, Pb-211, Pb-214, and Bi-211. Nb-93m is related to Zr-93. Pu-241 concentrations are inferred from Pu-238, Pu-239, and Pu-240. The radionuclides listed in parenthesis under the analyte column are measured as part of the analysis of the adjacent radionuclide.

^bThe analytical techniques are listed in the order that they should be performed. Gross alpha, gross beta, and VOA analyses will always be done first. Gamma spectrometry will be done next because it generally does not require destruction of any sample. Alpha spectrometry, Sr-90, and Tc-99 analyses will next be done if sufficient sample exists. The next priority is to perform ICP analyses. Approximately 2 lb (1 kg) of material will be required to perform these primary analyses. If more sample exists, several additional, secondary analyses may be performed. These are shown in the table below the ICP analysis. In borings, additional drive samples should be collected, if possible, to ensure that all analyses can be run.

^cThe uranium analyses will be conducted periodically to confirm the uranium concentrations calculated from the Pa-234m or Pa-231 analyses.

^dAll samples submitted for offsite radionuclide analysis will be placed in 9 P/G 1,000-mL bottles.

^eAll samples submitted for Metals analysis will be placed in a P 1,000-mL bottle.

^fAnalytical methods for radionuclide analysis are laboratory specific and, by contract with WHC, must meet analytical requirements for level IV. (Examples of standard methods include American Society for Testing and Materials [ASTM] D3549, ASTM D3865, ASTM D3972, ASTM D2334.)

^gVolumes listed are for TMA except where noted in comment column for split analysis where bottle size differs.

^hThis analysis will be run onsite at the 222-S Laboratory; the procedure is laboratory specific and is on file and available for review at the laboratory.

Table 2. Analytical Methods for Target Analytes - Soils. (sheet 1 of 2)

Analyte ^a	General Analytical Technique ^b	Soil and Sediment Analysis Method	Container and Volume ^c	Comments
Gross Alpha Gross Beta	Gas proportional	f	d	--
VOCs	GC/MS	CLP-VOAs	Gs 250 mL	VOA and Semi-Volatile Organic Analysis have 14-day hold times, requiring samples to be shipped within 10 days after sampling at the latest.
Semivolatile Organic Contaminants	GC/MS	CLP Semi-Volatile Organic Analysis	aG 250 mL	
All Identifiable and Quantifiable Isotopes	Gamma Spectrometry	f	d	
Iodine-129 Strontium-90 Technetium-99 ^h	Beta Counting	f	d	
Nitrate Nitrite	Ion Chromatography	300	G 125 mL	
Cyanide	Colorimetric	CLP-TAL	G 125 mL	
Fluoride	Ion Chromatography	300	G 125 mL	
Americium-241 Curium-244 Neptunium-237 Plutonium-238 Plutonium-239/240 Uranium-234 ^c Uranium-235 ^c Uranium-238 ^c	Alpha Spectrometry	f	d	
Arsenic Selenium	Graphite Furnace Atomic Absorption	CLP-TAL	e	
Mercury	Cold Vapor Atomic Absorption	METALS	e	
Aluminum Antimony Barium Beryllium Cadmium Calcium Chromium Cobalt Copper Iron Lead Magnesium Manganese Mercury Nickel Potassium Silver Sodium Thallium Vanadium Zinc	ICP Analysis	CLP-TAL	e	

Table 2. Analytical Methods for Target Analytes - Soils (sheet 2 of 2)

Sample volumes listed in this table are estimated based on contract laboratory requirements as of October 1994. Sampling personnel should follow volume requirements listed in the task-specific Sample Authorization Form.

aG	=	amber Glass
CLP	=	Contract Laboratory Program
G	=	Glass
Gs	=	Glass septum w/zero headspace
ICP	=	Inductively coupled plasma
M	=	method modified to include extraction from the solid medium, extraction method is matrix and laboratory-specific
P	=	Plastic
TAL	=	Target analyte list
TBD	=	To Be Determined
VOA	=	volatile organic analysis

ASTM (1985), DOE/EML (1990), EPA (1980a, 1980b, 1983, 1984, 1986).

^aIn addition to the analytes listed in this table, there are many progeny isotopes whose concentrations may be derived from known parent concentrations. Radionuclides related to U-238 include Th-230, Bi-210, Bi-214, Po-214, and Po-218. Radionuclides related to U-235 include Th-231, Tl-207, Pb-211, Pb-214, and Bi-211. Nb-93m is related to Zr-93. Pu-241 concentrations are inferred from Pu-238, Pu-239, and Pu-240. The radionuclides listed in parenthesis under the analyte column are measured as part of the analysis of the adjacent radionuclide.

^bThe analytical techniques are listed in the order that they should be performed. Gross alpha, gross beta, and VOA analyses will always be done first. Gamma spectrometry will be done next because it generally does not require destruction of any sample. Alpha spectrometry, Sr-90, and Tc-99 analyses will next be done if sufficient sample exists. The next priority is to perform ICP analyses. Approximately 2 lb (1 kg) of material will be required to perform these primary analyses. If more sample exists, several additional, secondary analyses may be performed. These are shown in the table below the ICP analysis. In borings, additional drive samples should be collected, if possible, to ensure that all analyses can be run.

^cThe uranium analyses will be conducted periodically to confirm the uranium concentrations calculated from the Pa-234m or Pa-231 analyses.

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^fAnalytical methods for radionuclide analysis are laboratory specific and, by contract with WHC, must meet analytical requirements for level IV. (Examples of standard methods include American Society for Testing and Materials [ASTM] D3549, ASTM D3865, ASTM D3972, ASTM D2334.)

^gVolumes listed are for TMA except where noted in comment column for split analysis where bottle size differs.

^hThis analysis will be run onsite at the 222-S Laboratory; the procedure is laboratory specific and is on file and available for review at the laboratory.

3.3 GENERAL DRILLING ACTIVITIES

The following sections describe the general drilling activities that will be conducted at each drill site. All drilling will be conducted utilizing the specifications and guidance presented in the *Washington Administrative Code* (WAC) Chapter 173-160, Part Three, "Resource Protection Wells," and the *Generic Well Specification*, WHC-S-014 (WHC 1990b). NOTE: The requirements presented in WAC Section 173-160-500, Item 2 ("No resource protection well shall interconnect saturated formations or aquifers") are not being violated when casing is carried through perching layers above the caliche layer. Drilling conducted in the area has shown that perching layers above the caliche layer are discontinuous and the system can be treated as a single hydrologic unit. No technical purpose is served by attempting to seal the boreholes against individual silt or clay beds that occur in the lower fine-grained units of the Hanford formation (Touchet-like beds). The perching units when encountered are typically several centimeters to no more than 0.305 m (1 ft) thick and are laterally discontinuous (see Appendix B for cross sections). Layers thicker than 1.5 m (5 ft) are not expected; however, if they occur and perched water is reported, the Washington State Department of Ecology (Ecology) will be informed and an evaluation will be performed to determine if casing will be downsized.

In support of the 200-UP-1 Operable Unit LFI, five borings will be drilled, sampled, and then converted to standard monitoring wells. The drilling operations will be conducted according to EII 6.7, "Resource Protection Well and Test Borehole Drilling," and EII 5.4, "Field Decontamination of Drilling, Well Development, and Sampling Equipment" (BHI 1994). All waste will be handled according to EII 4.3, "Control of CERCLA and Other Past-Practice Investigation Derived Waste" (BHI 1994), and the Waste Control Plan. Temporary casing will be used to minimize slough in the borehole and limit the transport of gross contamination if encountered. All boreholes will be constructed to ensure that 8-in. temporary casing is used in drilling to the screened interval.

Radionuclide logging system gamma spectrometer logging will be conducted on each string of casing prior to downsizing and after reaching total depth on boreholes UP1-12 and UP1-13, and some combination of cased intervals at the cluster site (UP1-9, UP1-10, UP1-11) such that the entire stratigraphic column is logged (this will be left flexible to expedite field activities). Geophysical logging will be conducted according to EII 11.1, "Geophysical Logging" (BHI 1994).

The site geologist will record all activities on the field activity report per EII 6.7, "Activity Reports of Field Operations" (BHI 1994). Items for entry will include borehole numbers, site location drawings, the names of site personnel, sampling types, and sampling intervals. The geologist shall measure and record the water level in the wells at the beginning and end of each shift.

All boreholes will be logged according to EII 9.1, "Geologic Logging" (BHI 1994). The geologic log will include the lithologic description, sample code, and depth; Hanford Environmental Information System (HEIS) numbers for each laboratory sample interval; borehole construction characteristics; screening results; and any general information the site geologist believes is pertinent to the characterization of the subsurface lithology. Each log sheet should contain no more than 20 ft of stratigraphic information.

3.4 MONITORING WELLS

To support the FY 1995 groundwater characterization activities for the 200-UP-1 Operable Unit, five wells will be constructed. Wells UP1-12 and UP1-13 will be constructed as single well sites that will monitor the top of the unconfined aquifer of the Unit E Ringold formation. Wells UP1-9, UP1-10, and UP1-11 will be constructed as a three-well cluster site that will monitor the middle and bottom of the unconfined aquifer within the Ringold Unit E and the top of the confined aquifer of Ringold Unit A. If practical, modifications to well UP1-10 may be made such that the DQO associated with well UP1-11 can be met without the installation of UP1-11. Any such modification will require regulator approval. The locations for well sites are presented in Figure 1. Table 3 and Appendix B present the estimated target drill depths for each well.

Table 3. Well Construction Parameters 200 West Area, 200-UP-1.

Well Number	Estimated Total Depth (ft)	Screen Length (ft)/ Diameter (in.)	Water Level (ft) ^a	Depth Top Screen (ft)	Depth Bottom Screen (ft)	Interval Sand Pack (ft)	Slug or Pump Test Interval (ft)	Comments
UP1-9	302	10/4	224	290	300	287-302	287-302	Middle, Ringold "E" aquifer
UP1-10	402	10/4	224	390	400	387-402	387-402	Bottom, Ringold "E" top of lower mud
UP1-11	470	10/4	224	457	467	452-470	225-235 290-300 390-400	Top, Ringold "A" aquifer base of lower mud
UP1-12	255	30/4	224	223	253	220-255	220-255	Top, Ringold "E" aquifer
UP1-13	246	30/4	215	214	244	211-246	211-246	Top, Ringold "E" aquifer

NOTE: All depths are estimates.

^aWater levels are approximately 1 year old; levels may have dropped since these were taken.

3.4.1 Design Specifications for Monitoring Wells

This section delineates well design criteria and specifications required for the installation of monitoring wells. General construction specifications and criteria for the drilling and construction of groundwater wells on the Hanford Site are provided in the *Generic Well Specification*, WHC-S-014 (WHC 1990b). WHC-S-014 supplies the design and construction standards necessary for the installation of monitoring wells capable of providing quality groundwater samples for the *Resource Conservation and Recovery Act* (RCRA) and *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA) groundwater monitoring and past-practice site investigation programs. In addition, specifications delineated in WHC-S-014 (or BHI equivalent specification) reflect the required well drilling and construction practices detailed in WAC-173-160 and WAC-173-162.

3.4.2 Screen and Filter Pack Selection for Monitoring Wells

All borings will be completed as 4-in. groundwater monitoring wells. When the target depth for each screened interval is reached (see Table 3), a split-spoon sample will be obtained and a sieve analysis performed. A screen and filter pack combination will then be selected that precludes approximately 90% of the formation fines from the well (typically either a 10- or 20-slot screen and 20-40 or 16-20 filter pack sand, respectively). After completing each well, limited development will be performed. When a sieve analysis cannot be performed, a 10-slot screen and 20-40 sand will be used.

3.5 AQUIFER TESTING

Groundwater monitoring wells will be slug tested after each well is completed. Slug testing will be conducted in accordance with EII 10.1, "Aquifer Testing." Pump/slug interference testing will be conducted at the cluster site if appropriate aquifer conditions are encountered based on recommendations in the 200-UP-1 Work Plan, Table 5-3 (DOE-RL 1994). Slug interference test procedures are presented in Appendix C. The approximate testing intervals are presented in Table 3. Water levels will be monitored in all wells during development activities and in any observation wells in the vicinity (when available) to provide additional aquifer characteristics.

3.6 WATER AND SOIL SAMPLING

3.6.1 Water Sampling

If perched water is reported above the Plio-Pleistocene layer in a borehole, drilling will stop and an initial baseline water level will be established. The amount of water in the borehole will be recorded on the borehole log and the field activity report. A water sample will then be obtained for chemical analyses using a bailer. At least 0.305 m (1 ft) of water is required for water sampling. A water sample will not be obtained if less than 0.305 m (1 ft) of water is present. When taking a perched water sample, an attempt will be made to fill all the bottles specified in Table 1. If (within 1 hour of the start of the sampling event) sufficient water cannot be obtained to fill the bottle requirements specified, sampling will stop and drilling will continue. Casing will not be downsized at the perching layer, and drilling will continue to the next casing point.

Perched water samples will be collected from boreholes per criteria discussed in Section 3.3 and EII 5.8, "Groundwater Sampling" (BHI 1994), and will be analyzed for the analytes presented in Table 1.

All groundwater samples will be collected after completion and development of the monitoring wells.

3.6.2 General Soil Sampling Requirements

Chemical/radiological and physical soil samples will be collected from boreholes UP1-10, UP1-11, UP1-12, and UP1-13. Chemical/radiological samples taken at the cluster site of wells UP1-9, UP1-10, and UP1-11 may all be taken in well UP1-11, which may be started first, or in a

combination of the three holes depending on drilling conditions. Physical properties samples will be collected from the planned screened interval of all wells in the cluster site regardless of which wells the chemical sampling is carried out on, in order to obtain sand pack design criteria.

Chemical/radiological samples will be obtained using the split-spoon sampler in accordance with EII 5.2, "Soil and Sediment Sampling" (BHI 1994), Table 4, and Appendix B. If insufficient samples are obtained to satisfy the required analysis, the split spoon can be redriven. The chemical portion of the sample will take precedence over physical samples. The drive barrel can be used to obtain type A physical properties when insufficient samples are obtained with the split spoon. An entry will be made in the borehole log identifying the sampling method using codes presented in Table 5.

Table 4. Proposed Sampling Intervals.

Boreholes UP1-9, UP1-10, and UP1-11		Borehole UP1-12		Borehole UP1-13	
Chem Sample Approx. Depth (ft)	Phys. Sample Approx. Depth (ft)	Chem Sample Approx. Depth (ft)	Phys. Sample Approx. Depth (ft)	Chem Sample Approx. Depth (ft)	Phys. Sample Approx. Depth (ft)
160	162A	165	167A	150	152A
190	192A	192	194A	170	172A
	215A		215A		220A
230	232B	230	232B	230	232B
310	312B				
400	402B				
	420C				
465	467B				
Total: 7	Total: 8	Total: 3	Total: 4	Total: 3	Total: 4
Top of Plio-Pleistocene carbonate layer at 193 ft		Top of Plio-Pleistocene carbonate layer at 193 ft		Top of Plio-Pleistocene carbonate layer at 170 ft	

NOTE: All sampling depths are estimates only and are based on expected lithology. The site geologist will pick sampling points based on lithology reported.

Table 5. Soil Sampling Codes.

Sample Type	Sample Type Designation	Purpose of Sample
Physical	PH	Provide material for determination of physical characteristics of vadose and saturated zone.
Chemical	CH	Provide material for chemical analysis to determine contaminant inventory and extent of contamination in the vadose and saturated zone.

Archive samples will not be collected on any of the five borings. Sufficient lithologic samples have been collected in the 200-UP-1 Operable Unit to satisfy future characterization needs.

3.6.3 Soil Sampling

All material removed from a borehole will be identified and described by the geologist and summarized on the borehole log. Proposed sampling intervals and expected subsurface lithology are presented in Table 4 and Appendix B.

Analytical samples will be collected as specified in EII 5.2, "Soil and Sediment Sampling" (BHI 1994). Packaging and shipping requirements for samples transported offsite shall be selected on the basis of total activity values and the preservation requirements applicable to the parameters of interest, as described in EII 5.11, "Sampling Packaging and Shipping" (BHI 1994).

This DOW presents only general guidance for obtaining samples. Because of the variability occurring in the field, the site geologist will need to use professional judgment to determine the appropriate intervals for obtaining samples. Recommended sampling depths for each borehole are presented in Table 4 and Appendix B. Field screening will be used to ensure that the most contaminated material from each sampling interval is submitted for analysis.

All samples shall have a representative portion submitted to the 222-S Laboratory for total activity analysis. This will be utilized for sample preshipment characterization. Chemical and radiological samples with a total activity of less than the established laboratory criteria will be analyzed at an offsite laboratory. Those samples exceeding the laboratory criteria will be routed to a designated onsite laboratory for analysis. Onsite and offsite laboratories will be identified prior to initiating field activities.

3.6.3.1 Physical Property Analysis. Three suites of physical property analyses (Types A, B, and C) are proposed for the various hydrostratigraphic units in the 200-UP-1 Operable Unit. A summary of the proposed sampling intervals is presented in Table 4 and Appendix B. An additional description for physical sampling is presented in Section 5.1.3.3.2 of the Work Plan (DOE-RL 1994).

Type A analyses will be performed on the early Palouse soils, Plio-Pleistocene unit, and the unsaturated portions of the Ringold Unit E gravels. Type A analyses will include the following:

- Moisture content
- CaCO_3 content
- Soil pH
- Particle size distribution.

Type B analyses will be performed on saturated portions of the Ringold Units E and A. Type B analyses will include the following:

- Bulk density
- Particle size distribution
- Soil pH
- CaCO_3 content
- Porosity

Type C analyses will be collected from the Ringold lower mud unit and will include the following:

- Bulk density
- Particle size distribution
- Vertical hydraulic conductivity

Chain-of-custody documentation will be prepared by the site geologist for each day's samples. The project geologist will supply HEIS numbers for physical samples to the site geologist at the beginning of borehole activities. Container requirements for physical samples are contingent on the size of material being sampled. Sample container requirements are presented in Table 6. The applicable WHC Geotechnical Engineering Laboratory (GEL) numbers presented below will be requested on the sampling and analysis request form. Physical samples will be analyzed using the following ASTM methods:

- Bulk density/porosity (GEL-16)
- CaCO_3 content (Gel-19)
- Moisture content (ASTM D2216) (Gel-14)
- Particle size distribution (ASTM D422-63) (Gel-07)
- Soil pH

All sample containers will be labeled with applicable borehole number, sampling date, time, depth interval to the nearest foot (physical samples only), HEIS number, requested analysis, and the sampler's initials. Chain-of-custody documentation as detailed in EII 5.1, "Chain of Custody" (BHI 1994), will be prepared by the site geologist.

3.6.3.2 Chemical and Radiological Analysis. Generally, soil samples for characterizing chemical and radiological contaminants will be collected from each boring at the Plio-Pleistocene unit, just above the water table, at appropriate intervals within the saturated zone, and from each screened interval. Additional samples may be collected if any contamination or perched water is encountered. A summary of the proposed chemical analytical methods is presented in Table 2. The approximate sampling intervals are presented in Table 4 and Appendix B.

Table 6. Physical Sample Bottle Requirements.

Analyses	Drive Barrel	Split Spoon
Type A Analyses		
Particle size distribution ^a (Gel-07)	One mason jar or one bag ^b	Two liners
Moisture content ^a (Gel-14)	One moisture tin or one mason jar ^b	Combine analyses with above liners
Calcium carbonate ^a (Gel-19)	Combine analyses with above samples	Combine analyses with above liners
Soil pH	Combine analyses with above samples	Combine analyses with above liners
Type B Analyses		
Bulk density/Porosity ^a (Gel-16)	Not taken	Two liners
Particle size distribution ^a (Gel-07)	One moisture tin and three mason jars or one moisture tin and one bag ^b	Combine analyses with above liners
Soil pH	Combine analyses with above samples	Combine analyses with above liners
Calcium carbonate ^a (Gel-19)	Combine analyses with above samples	Combine analyses with above liners
Type C Analyses		
Bulk density/Porosity ^a (Gel-16)	Not taken	Two liners
Vertical hydraulic cond.	Not taken	Combine analyses with above liners
Particle size distribution ^a (Gel-07)	One mason jar or one bag ^b	Combine analyses with above liners
HPT release	One small plastic bag	One plastic bag

^aWestinghouse Hanford Company Geotechnical Engineering Laboratory method procedure number (Gel-#)

^bContainer type dependent on size of material sampled.

Chain-of-custody documentation will be prepared by the sampling scientist. Container and volume requirements for chemical and radiological soil samples are presented in Table 2. The laboratory will use existing Level IV CLP methods. Level V CLP methods for radionuclide analysis and Level III analysis for anions will be used as approved in laboratory contracts.

If full sample volume requirements cannot be met, the volume obtained will be recorded in the sampling scientist's logbook per EII 1.5, "Field Logbook" (BHI 1994), and analyzed in the following order:

1. Radionuclides
2. Volatiles
3. Semivolatiles
4. Target analyte list (metals)
5. Anions.

4.0 QUALITY ASSURANCE/QUALITY CONTROL REQUIREMENTS

Internal quality control samples shall be collected at each facility by the sampling scientist as specified in "Quality Assurance Project Plan" (DOE-RL 1994, Appendix A) with the revisions as outlined below. The sampling shall be documented in the sampling logbook per EII 1.5, "Field Logbooks" (BHI 1994).

- Field Duplicate Samples. A minimum of one duplicate per sampled borehole/well cluster or one duplicate for every 20 samples shall be collected, whichever is greater. Duplicate samples shall be retrieved from the same sampling location using the same equipment and sampling technique and shall be placed in two sets of identically prepared and preserved containers. All field duplicates shall be analyzed independently to provide an indication of the reproducibility of sampling and/or analysis techniques.
- Split Samples. At the direction of the project geologist, and if a laboratory is designated, split samples may be collected at the same frequency as duplicate samples.
- Field Blanks. Field blanks shall consist of pure deionized water or silica sand (depending on the medium being collected) and transferred into clean sample containers at the site. Field blanks are used as a check on environmental contamination and shall be collected for each borehole/well cluster, or one for every 20 samples, whichever is greater.
- Equipment Rinsate Blanks. Equipment rinsate blanks consist of pure deionized water or silica sand (depending on the medium being collected) that is run through decontaminated sampling equipment and placed in clean sample containers. Equipment blanks are used to verify the adequacy of sampling equipment decontamination procedures and may be collected at the direction of the project geologist.

- Volatile Organic Analysis Trip Blanks. The VOA trip blanks consist of pure deionized water or silica sand (depending on the medium being sampled) added to clean sample containers under controlled conditions and accompanying each batch of coolers shipped to the analytical facility. Trip blanks may be shipped unopened to the laboratory per the direction of the project geologist and would be prepared as a check on possible contamination originating from container preparation methods, shipment, handling, storage, or site conditions. The trip blank shall be analyzed for volatile organic compounds.

5.0 SCHEDULE

The following tentative schedule is for drilling in the 200-UP-1 Operable Unit for 1995 (assuming the availability of two drill rigs). This schedule is subject to change, and the operable unit task lead should be contacted for the current status. An agreement Activity Notification Form will be issued at least 5 days before the start of field work.

Well Number	Drilling Dates
UP1-11	Early February -- Late April
UP1-12	Early February -- Mid March
UP1-13	Mid March -- Late April
UP1-10	Late April -- Late July
UP1-9	Late April -- Early July

6.0 AS LOW AS REASONABLY ACHIEVABLE CONSIDERATIONS AND CHANGES TO THE DESCRIPTION OF WORK

All boreholes will be drilled utilizing the guidance of the as low as reasonably achievable (ALARA) program.

Minor changes to this DOW, such as a change in sampling methods, analyzing different parameters, using different analytical methods, or significantly changing the sampling interval, will be submitted on the attached form (Attachment 1) and kept on file with the operable unit coordinator. Copies will be submitted to the regulatory agencies, project quality assurance engineer, and the appropriate field personnel within 10 working days of the occurrence.

Any major changes to this document such as a significant revision of the target analyte list or well completion depths will require regulator approval.

7.0 REFERENCES

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Attachment 1

200-UP-1 DESCRIPTION OF WORK

PROJECT CHANGE FORM

Date:

Person Initiating Change:

Change:

Reason for Change:

APPROVAL:

Field Team Leader:

Operable Unit Coordinator:

Quality Assurance:

Attachment 2

Page 1 of 1

TELEPHONE CONFERENCE MEMORANDUM

Company: WHC

Address:

[] Incoming [X] Outgoing

Date: April 9, 1993

Time: 9:00 a.m.

With: K. Kowalik *K.K.*

of: Ecology

Phone: 206-438-7525

With: Marty Gardner

of: Environmental Field Services Phone: 376-2908

Copies to:

Name

Address

M. G. Gardner

N3-06

R. L. Jackson *R.J.*

H6-06

J. F. Keller

L4-03

K. D. Reynolds

H6-06

R. R. Thompson

L4-06

Subject: Discussion of: 1) Remediation of Z-20 wells - 299-W18 - 17, 18, 19 and 20
2) Geohydrologic conditions at U-14 Ditch

Geosciences Function

372-0540

Department

K.D. Reynolds
K. D. Reynolds

Telephone #

Summary of Conference

- 1) A detailed discussion of cementing plans for the four wells along the Z-20 Ditch was held. K. D. Reynolds explained the reasoning and data used to define the intervals selected for cementing. M. D. Gardner explained the techniques that will be employed. After discussion, K. Kowalik gave verbal approval to proceed with the planned remediation.
- 2) A brief discussion of the current knowledge of the perching conditions being encountered at the U-14 Ditch drilling project was held. Based on information gathered from 299-W18-250 and 251 and from wells in the area WHC Geosciences and K. Kowalik of State of Washington Department of Ecology agreed that the Touchet facies of the Hanford formation should be treated as a single hydrologic unit and no technical purpose would be served by attempting to seal individual silt/clay beds within the Touchet member.

APPENDIX A

EXCERPTED SECTIONS FROM WORK PLAN

APPENDIX A

EXCERPTED SECTIONS FROM WORK PLAN

The following pages are excerpted from:

DOE-RL, 1994, *Remedial Investigation/Feasibility Study Work Plan for the 200-UP-1 Groundwater Operable Unit, Hanford Site, Richland, Washington*, DOE/RL-92-76, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

Permits and Hazardous Waste Operating Permits (EII 2.2, "Occupational Health Monitoring"[WHC 1988]) is planned to be performed prior to the start of any sampling activity. All personnel entering the job site will fulfill the minimum requirements for entry as discussed in EII 1.1., "Hazardous Waste Site Entry Requirements" (WHC 1988).

An as-low-as-reasonably-achievable (ALARA) plan that addresses the potential radiation exposure of task personnel during field tasks is planned to be completed prior to the commencement of field operations. Guidance on such assessments is found in WHC-CM-4-11 as referenced in EII 2.3, "Administration of Radiation Surveys to Support Environmental Characterization Work on the Hanford Site" (WHC 1988). A Radiation Dose Assessment evaluation may be performed for the anticipated soil samples and upon its completion may be used in conjunction with estimates of sample size and duration of exposure to prepare an ALARA plan.

5.1.2.9 Community Relations (Subtask 1j). Community relations activities are planned to be conducted in accordance with the Community Relations Plan for the Hanford Site (Ecology et al. 1989). All community relations activities associated with the 200-UP-1 Groundwater Operable Unit will be conducted under this overall Hanford Site Community Relations Plan.

5.1.3 Limited Field Investigation Field Activities (Tasks 2 to 6)

This section describes the proposed field activities to be performed for the LFI. The field activities are designed to accomplish the following tasks: source characterization (Task 2), geologic investigation (Task 3), vadose zone investigation (Task 4), groundwater investigation (Task 5), and air investigation (Task 6). These tasks are described in Section 5.1.1. Section 5.1.3 recommends specific activities to be conducted for the LFI, although final determination of field activities will be made through issuance of DOWs. Several DOWs will be required and will likely address the following topics:

- Accelerated vertical contaminant profiling (*Description of Work for the 200-UP-1 Groundwater Contaminant Vertical Profiling Activity* [WHC 1993b])--Indicates the locations, methodology, and analytical methods for the vertical contaminant profiling
- Soil sampling, monitoring well installation, groundwater sampling, and geophysical surveys--Identifies locations, frequencies, methodologies, and analytical methods for the subject field activities
- Aquifer testing, including accelerated 1993 aquifer testing (*Description of Work for the 200-UP-1 Aquifer Testing Activity* [WHC 1993c])--Identifies the locations, methodology, and analyses for aquifer tests.

Section 5.1.3.1 discusses the locations and frequencies of each activity, and is subdivided by waste management unit and unplanned release. The protocols and procedures for each type of field activity are described in

Section 5.1.3.2. Section 5.1.3.3 describes the laboratory analyses that each sample will undergo.

5.1.3.1 Sampling Locations and Frequencies. The following sections describe the recommended field activity for each data collection category.

5.1.3.1.1 Well Condition and Survey Assessment. Existing resource protection wells within the 200-UP-1 Groundwater Operable Unit should be used whenever possible to provide hydrogeologic and chemical information to support IRM/LFI activities. The suitability of wells used for these purposes should be assessed as part of the 200-UP-1 Groundwater Operable Unit Remedial Investigation/Feasibility Study. As a strategy to complete this assessment, information from an ongoing Westinghouse Hanford Environmental Field Services well remediation program should be incorporated, as available, to guide field activities and data analysis efforts.

Well remediation at the Hanford Site is currently implemented on a well-by-well basis as driven by specific requirements of individual site programs and characterization activities. Criteria for assessing the fitness-for-use of individual wells are described in EII 6.6 (WHC 1988). The intent of remediation is to bring wells constructed prior to incorporation of current Washington State well construction standards (Chapter 173-160 WAC) in line with new well regulations and current Hanford Site well construction practices. The objective is to remediate wells with documented deficiencies so that they may be used for resource protection wells or for other purposes where feasible. Generally, all pre-1987 wells are considered to be suspect.

For the purpose of the 200-UP-1 Groundwater Operable Unit, compliance status of existing wells under EII 6.6. and Chapter 173-160 WAC should first be reviewed during planned work plan activities. Based on results of this review a list of wells requiring further remediation should be prepared based on the intended purpose for groundwater sampling or water elevation measurements. Wells with high potential for transporting contaminants along poor or nonexistent annular seals should be given priority for remediation. Remediation efforts should be considered on a case-by-case basis. Remediation options include perforation and grout injection to create an annular seal. These wells should not be used for groundwater sampling unless it can be demonstrated that the deficiency is unlikely to affect analytical results. The wells may also be acceptable for other purposes such as water level elevation measurements or aquifer testing. Wells presenting a high risk for providing vertical pathways for contaminant transport will be scheduled for abandonment according to procedures in EII 6.7 (WHC 1988). As discussed in Section 4.2.6.4 (Existing Well Quality), it is recommended that the well fitness-for-use and survey quality evaluation be completed in a prioritized manner. Initial priority should be given to wells listed in Table 5-2 since sampling and analysis results of groundwater samples from these wells will be used to determine the disposition of the LFI constituents and further define the extent of IRM constituents. Operable unit wells with detected LFI/IRM constituents should then be evaluated, followed by the remaining 200-series wells, and lastly the remaining 600-series wells.

An additional component of the well suitability assessment is the verification of existing wellhead elevation and location surveys. Questions of survey accuracy are generally restricted to older (pre-1987) wells. Wells that are currently scheduled for resurvey are indicated in Table 5-2. Resurvey of existing wells should be staged in a similar manner to that described above for fitness-for-use.

In many cases, well construction records of older wells (1950's) are missing or incomplete. When available, completion records of existing wells would be reviewed to identify wells for which the screened interval is unknown or uncertain. In such cases, wells should be visually inspected with a downhole camera, as necessary, to determine screened intervals. In addition, continued dissipation of elevated water table levels in areas of mounding may lead to wells screened across the water table to go dry in such locations. Wells for which recent water level records indicate that the screen may become stranded above the water table should be identified as part of the proposed work plan effort, and monitoring of water levels should occur on a quarterly basis to verify that such wells would be permanently stranded rather than temporarily stranded because of seasonal fluctuations in the water table. Stranded wells in locations that are considered critical to water quality monitoring and water level elevation determination should then be recommended for replacement.

5.1.3.1.2 Borings and New Well Installation. Thirteen proposed new wells, UP1-1 through UP1-13, may be installed at eight locations as part of this work plan. The installation of these wells will meet the requirements of WAC 173-160, WAC 173-162, and Revised Code of Washington (RCW) 18.104 with the guidance of the Environmental Compliance Support Organization. The location of the proposed new wells are shown on Figure 4-2. The estimated depth and screen interval and the primary DQO for each well is summarized in Table 5-4. A graphical representation of each well showing the well depth, approximate depth of the lithologic units encountered, and sampling intervals is presented on Figures 5-1 through 5-8. In cases where more than one well at a location will be installed, only soil from the deepest well in each assemblage will be sampled during drilling (unless a well screen interval sample is needed). This approach is adopted to expedite drilling, with the understanding that wells are located sufficiently close so that stratigraphic variations are negligible. The purpose of these wells is to help further characterize contaminant plumes and groundwater flow in the 200-UP-1 Groundwater Operable Unit. Plans for new well installations will be finalized in a DOW.

Five wells (UP1-1, if required, -6, -7, -12, and -13) should be installed to better delineate the horizontal extent of the plumes in the 200-UP-1 Groundwater Operable Unit. These wells will be screened in the upper 10 m (30 ft) of the uppermost aquifer. The reason for screening the upper 10 m (30 ft) is to ensure that the water table will be intersected by the screen, even if water levels continue to fall in accordance with the recent trend. Samples collected during drilling will be used to analyze the physical and chemical properties of the vadose and saturated zones. Sampling recommendations are discussed in Section 5.1.3.3 and shown on Figures 5-1 through 5-5. If the Vertical Profiling Test Program (WHC 1993b) demonstrates that Well 299-W19-4

is suitable for sampling the top of the uppermost aquifer, Well UP1-1 may not be installed.

Four wells, UP1-2 (if needed), -3, -4, and -5, will be installed in a cluster adjacent to Well 299-W19-24. Well 299-W19-24 is screened from 72 to 77 m (235 to 255 ft) across the top of the uppermost aquifer. The current depth to the top of the uppermost aquifer in Well 299-W19-24 is 73 m (238 ft). Well UP1-2 should be screened from 98 to 101 m (320 to 330 ft). Well UP1-3 should be screened at the bottom of the uppermost aquifer at the base of Ringold Unit E. Well UP1-4 should be screened in the confined aquifer in Ringold Unit A. Well UP1-5 should be screened in the confined aquifer in the Rattlesnake Ridge interbed. This well will not be installed until after operable unit IRM activities are completed. In order to expedite drilling, samples will be collected during drilling of Well UP1-4 and from the depth of the screened interval in the other wells. The samples will be used to analyze the physical and chemical properties of the vadose and saturated zones. Sampling recommendations are discussed in Section 5.1.3.3 and shown on Figure 5-6. These four wells will provide data on the vertical extent of the uranium and ⁹⁹Tc plumes, groundwater flow, and the underlying stratigraphy.

Well UP1-8 should be installed adjacent to Well 299-W23-14. Well 299-W23-14 is screened from 59 to 65 m (193 to 215 ft) across the top of the uppermost aquifer. The current depth to the top of the uppermost aquifer in Well 299-W23-14 is 61 m (200 ft). Well UP1-8 will be screened in the confined portion of the uppermost aquifer in Ringold Unit A. Samples collected during drilling will be used to analyze the physical and chemical properties of the vadose and saturated zones. Sampling recommendations are discussed in Section 5.3.3 and shown on Figure 5-8.

Three wells, UP1-9, -10, and -11, should be installed in a cluster adjacent to Well 299-W22-20. The current depth to the top of the uppermost aquifer in Well 299-W22-20 is 67 m (219 ft). Well UP1-9 will be screened from 91 to 94 m (300 to 310 ft). Well UP1-10 will be screened at the bottom of the uppermost aquifer at the base of Ringold Unit E. Well UP1-11 will be screened in the confined portion of the uppermost aquifer in Ringold Unit A. In order to expedite drilling, samples will be collected during drilling of Well UP1-13 and at the depth of screened intervals in the other wells. The samples will be used to analyze the physical and chemical properties of the vadose and saturated zones. Sampling recommendations are discussed in Section 5.3.3 and shown on Figure 5-9. These three wells will provide data on the vertical extent of the chromium, nitrate, carbon tetrachloride, chloroform, and trichloroethylene plumes, as well as provide data to assist determination of groundwater flow and refine knowledge of stratigraphy.

5.1.3.1.3 Soil Vapor Sampling. Because large volumes of volatile chemicals were not disposed of in waste management units overlying the 200-UP-1 Groundwater Operable Unit, no soil vapor sampling is planned for the 200-UP-1 Groundwater Operable Unit investigation. Low concentrations of volatile organics in groundwater and information from process and disposal records indicate that testing for vapors in the vadose zone is not warranted because of the unlikelihood of a positive result. Soil vapor sampling may be used in

the 200-ZP-1 Groundwater Operable Unit investigation and in the source operable unit investigations.

5.1.3.1.4 Groundwater Sampling. Many of the existing wells in the 200-UP-1 Groundwater Operable Unit, and all the new wells to be installed, should be sampled and analyzed for appropriate constituents. Before groundwater sampling begins, the historical analytical data should be reviewed carefully. Upon completion of this review, changes in the recommended sampling requirements will be made, if needed. Table 5-2 summarizes the recommended sampling requirements (analytes in each well).

In all these wells, the sampling should be begun on a quarterly basis for one year. Subsequently, sampling will be continued according to need based on the results during the first year of sampling.

Unfiltered samples for inorganics are required to support the QRA. It is anticipated that wells being sampled may produce turbid samples containing suspended solids. Such materials likely originate from aquifer soils in the immediate vicinity of the well, rather than representing transported residues from disposed wastes. Because the sediment contains inorganic compounds, samples collected for inorganic analysis will be analyzed for both dissolved (filtered) and total (unfiltered) concentrations.

5.1.3.1.5 Water Level Measurements. To support work plan activities for the operable unit, it is recommended that static water levels in existing groundwater wells located in the 200-UP-1 Groundwater Operable Unit will be monitored on a quarterly basis throughout the duration of field and analytical activities discussed in the work plan. Wells to be monitored should include all new wells and wells identified on Plates 1a and 1b. Monitoring should incorporate measurements from wells installed as part of the current work plan, and measurements from groundwater monitoring efforts and aquifer testing will also be included.

Water level elevations are currently measured for many of the 200-UP-1 Groundwater Operable Unit wells. These measurements are obtained as part of on-going site-wide monitoring programs from RCRA, CERCLA, and Hanford Operational Groundwater Monitoring Network programs. These programs and the wells included within each program are discussed in Section 2.8 of the 200 West Groundwater AAMSR. Many of these wells are monitored on a quarterly basis at a minimum. The proposed monitoring efforts for the 200-UP-1 Groundwater Operable Unit should, to a large extent, use groundwater elevation data obtained from these programs to optimize the use of this information. Wells within the operable unit that are not currently included in these programs will be identified and incorporated into the monitoring network. Wells scheduled for abandonment will be checked, and wells installed for other programs will be added to the monitoring network for the 200-UP-1 Groundwater Work Plan as needed.

5.1.3.1.6 Geophysical Surveys. Subsurface geophysics are recommended to be run in nine of the new well boreholes and on four existing wells. The locations of these wells are shown on Figure 5-9. Only the deepest new well at a location will be surveyed with the assumption that variability over the

close spacing is negligible. The list of wells and methods will be finalized in a DOW.

Geophysical surveys of the new wells should be performed as each casing string reaches its maximum depth to avoid surveying portions of boreholes through two casings and intervening grout. Gross gamma logging will be performed in Wells UP1-1 (if installed), -4, -5 (from the base of the Ringold Unit A through the Rattlesnake Ridge interbed), -6, -7, -8, -11, -12, and -13 in advance of the placement of casings. The RLS spectral gamma surveys will be conducted on these new wells following well installation. Although running both gross gamma logging and RLS spectral gamma logging in the new wells may be redundant, it is recommended that both techniques be used because of various limitations in both types of logging. These limitations include the length of time for running RLS logs, the length of the specialized cable for the RLS detector is not long enough to log the deepest new wells, and the inability of gross gamma logging to detect uranium. In addition gross gamma logging could save time by identifying intervals that would saturate an unshielded RLS detector, and gross gamma logs are more readily correlated with other wells in the area because of the historically more extensive use of gross gamma logging.

Gross gamma logging also should be conducted in Wells 299-W22-2 and 299-W22-30. These two wells monitor the 216-S-1 and 216-S-2 Cribs. Previous gross gamma logging of these well has shown elevated gross gamma levels throughout the vadose zone to the water table. These wells have not been logged since 1980. The new logs will be compared with the old logs to see if any appreciable changes have occurred in gross gamma levels in these wells.

The RLS spectral gamma logging should be conducted in four existing wells. The four existing wells are Wells 299-W22-2 and 299-W22-30, which monitor the 216-S-1 and 216-S-2 Cribs, 299-W22-25 which monitors the 216-S-9 Crib, and 299-W22-13, which monitors the 216-S-7 Crib. This logging should be coordinated with any future investigations of the S Plant Source Aggregate Area. The spectral gamma logs will provide information on the radionuclides responsible for the elevated gross gamma in these wells in the vadose zone immediately above the water table.

The 200-UP-2 Source Operable Unit field investigation calls for spectral gamma logging in eight existing monitoring wells and five new borings. The existing wells are Wells 299-W19-3, 299-19-9, 299-19-11, 299-W19-69, 299-W19-70, 299-W19-71, 299-W22-62, and 299-W22-75. Spectral gamma logging will be conducted during spring 1993 at Wells 299-W19-9, 299-W19-11, 299-W19-70, and 299-W22-75 as part of the *200 West Groundwater AAMS* screening study (WHC 1991). The new borings that will be logged will be located near the 216-U-1, 216-U-2, and 216-U-8 Cribs, 216-U-4 Reverse Well, and 216-U-4A French Drain.

5.1.3.1.7 Aquifer Tests. The proposed aquifer tests to gather data on hydraulic properties data are based on the data needs and DQOs discussed in Section 4.2.3. Aquifer tests were conducted in 1993 for accelerated field activities and are planned along with other LFI activities following new well installation. Table 5-3 summarizes the recommended aquifer testing program for the 200-UP-1 Groundwater Operable Unit. The table identifies wells to be

tested for the unconfined portion of the uppermost aquifer (Ringold Unit E gravels), the confined portion of the uppermost aquifer (Ringold Unit A gravels), and the Rattlesnake Ridge interbed confined aquifer using a variety of testing methods. The wells identified for deeper aquifer tests should be installed as nested completions that will also be used to collect groundwater samples for chemical analysis and collect water level elevation data (see Sections 5.1.3.1.2 and 5.1.3.1.4). The Rattlesnake Ridge interbed well is planned to be installed following completion of operable unit IRM activities.

Proposed testing methods listed in Table 5-3 include slug, slug interference, constant rate drawdown/recovery pumping tests, and short term pressure buildup tests. Section 4.2.3 discusses the rationale, application, and the advantages and limitations for each type of test and their variations. Specific information regarding the anticipated screen intervals in the test wells, observation wells for each test, and methods of data analysis are presented in Table 5-3. Final determination of the scope and methodology of this field activity is planned in a follow-on DOW.

5.1.3.2 Protocols and Procedures.

5.1.3.2.1 Well Condition and Survey Assessment. To complete the operable unit well condition and survey assessment, a record search should initially be conducted to gather well completion and survey data for existing wells within the operable unit. Wells for which the depth of screen intervals is uncertain or unknown would be identified and assessed by use of a downhole camera. Wells for which survey data are uncertain or unknown will be recommended for resurvey using a licensed professional surveyor familiar with the Hanford Site. Vertical and horizontal measurements will be referenced to U.S. Geological Survey/National Geodetic Survey bench marks or other permanent reference points. As discussed in Section 5.1.3.1.1, this effort is intended to incorporate available information from well compliance status and remedial assessment work planned by Westinghouse Hanford in 1993/1994.

5.1.3.2.2 Soil Borings/Sampling. Thirteen proposed boreholes may be drilled during the 200-UP-1 Groundwater Operable Unit field investigation. The general locations of these well borings are discussed in Section 5.1.3.1.2 and shown on Figure 4-2. The depths and geologic units to which the well borings will extend are shown in Table 5-4. Schematic diagrams showing stratigraphic units, depth of well screen, and sampling intervals of the borings are shown on Figures 5-1 through 5-8.

Drilling. The suggested drilling technique used on the boreholes should be air rotary with a downhole hammer or one of other acceptable technologies, with selection of the method to be made in a DOW. Drilling operations will be conducted according to EII 6.7, "Resource Protection Well and Test Borehole Drilling," and EII 5.4, "Field Decontamination of Drilling, Well Development and Sampling Equipment" (WHC 1988). Drilling cuttings will be managed according to EII 4.2, "Interim Control of Unknown, Suspected Hazardous and Mixed Waste" and EII 4.3, "Control of CERCLA and Other Past-Practice Investigation Derived Waste" (WHC 1988). As drilling proceeds, the well-site geologist will complete the borehole geologic log in accordance with EII 9.1, "Geologic Logging" (WHC 1988).

Temporary casing will be advanced along with drilling. Casings will be telescoped through the various aquifers, perched water, if encountered, and intervals of contamination to prevent cross contamination. The approximate casing sizes to be used will likely be 20, 25, 30, and 40 cm (8, 10, 12, and 16 in.) casings. For the five plume delineation well borings and the three boreholes to Ringold Unit A, UP1-1, -4, -6, -7, -8, -11, -12, and -13, gross gamma logging will be performed whenever the casing is telescoped. Gross gamma logging will also be performed in the UP1-5 well boring. The survey procedures are outlined in Section 5.3.2.4. Each telescoped casing, when its total depth has been achieved, will be cut and left in place so that it extends about 0.2 m (0.5 ft) above the next larger diameter casing.

Sampling. The split-spoon and/or core sampler should be the primary device for collecting soil samples for chemical and physical analyses during drilling. Recommended intervals for collecting chemical and physical samples are shown on Figures 5-1 through 5-8 and the analyses are discussed in Section 5.1.3.3. Archive samples will be collected at 3 m (10 ft) intervals from cuttings. All depths will be recorded to the nearest 0.025 m (0.10 ft). Sample intervals may be extended by driving the sampler a second time if an insufficient sample is collected during the first attempt. If samples cannot be obtained due to lithologic conditions, material from the drive barrel or sediment trap will be collected. At locations where multiple wells will be installed, samples will be collected from the deepest well and from the depths of the screened interval in the shallower wells.

Chemical samples will be collected and handled in accordance with EII 5.1, "Chain of Custody" (WHC 1988) and EII 5.2, "Soil and Sediment Sampling" (WHC 1988). Chemical samples will be collected with a split-spoon and/or core sampler with stainless steel liners. The sampler and liners will be decontaminated before use according to EII 5.5, "1706 KE Laboratory Decontamination of Resource Conservation and Recovery Act/Comprehensive Environmental Response, Compensation, and Liability Act (RCRA/CERCLA) Sampling Equipment" (WHC 1988). Prior to sampling, slough in the borehole will be removed to the greatest extent possible. Sampling personnel will transfer samples from the sample liners to the appropriate sample containers and preserve them in accordance with the EPA guidelines set forth in *Test Methods for Evaluating Solid Wastes* (EPA 1986). All chemical samples will be geologically logged by the well-site geologist. Chemical samples will be labeled with the appropriate Hanford Environmental Information System (HEIS) number to accommodate sample tracking and data entry into the HEIS.

All samples and cuttings will be field screened for organic volatiles and radionuclides. Volatiles will be screened by a qualified technician using an organic vapor monitor. Radionuclides will be screened by alpha and gamma counting instruments. All instruments will be used, maintained, and calibrated in a manner consistent with EII 3.2, "Calibration and Control of Monitoring Instruments" (WHC 1988), and EII 3.4, "Field Screening" (WHC 1988). The field geologist will record screening results in the borehole log (EII 9.1, "Geologic Logging" [WHC 1988]). If contamination is indicated by field screening or perched water is encountered, additional chemical samples will be collected for analyses as described in Section 5.1.3.3.

Physical samples will be collected by the same procedures as for chemical samples. Portions of physical samples that have been unconditionally radiologically released will be sent to an existing storage facility to be archived. Contaminated samples will be sent to a long-term storage facility if one is available. If one is not available, such samples will not be retained. The nonradioactive samples will be archived according to EII 5.7A, "Hanford Geotechnical Sample Library Control" (WHC 1988).

5.1.3.2.3 Well Completion. Wells will be completed according to procedures outlined in EII 6.8, "Well Completion" (WHC 1988). The design of wells will be as described in "Generic Specifications - Groundwater Monitoring Wells" (WHC 1991). In general, wells will be constructed of 10 cm (4 in.) inner diameter 304 stainless steel, joint threaded casing, and wire-wrap well screen. The screen slot and pack sand size will be determined from the results of sieve analysis.

5.1.3.2.4 Groundwater Sampling. Groundwater sampling should be carried out under the guidance of EII 5.8, "Groundwater Sampling" (WHC 1988). The only modification will be the measurement of Eh (by probe) simultaneously with the measurements for the other parameters (temperature, pH, and specific conductivity) at the time of sampling (i.e., after purging is complete).

5.1.3.2.5 Geophysical Surveys. Subsurface geophysics should be run in the five plume delineation well boreholes (UP1-1, -6, -7, -12, and -13) and the three Ringold Unit A well boreholes (UP1-4, -8, and -11) as each casing string reaches its maximum depth. Subsurface geophysics will also be run in well borehole UP1-5 from the base of Ringold Unit A through the Rattlesnake Ridge interbed. Boreholes will be logged according to EII 11.1, "Geophysical Survey Work" (WHC 1988).

In addition to the new well boreholes schedule for surveying, subsurface geophysics will be run in four existing wells (Figure 5-9). Wells 299-W22-2 and 299-W22-30 will be logged for gross gamma. The RLS spectral gamma logs will be run in Wells 299-W22-2, 299-W22-30, 299-W22-25, and 299-W22-13. The RLS spectral logging will be done in other wells within the 200-UP-1 Groundwater Operable Unit as part of the 200-UP-2 Source Operable Unit field investigation and as part of the 200 Area AAMSR screening study (WHC 1991).

5.1.3.2.6 Water Level Measurements. Groundwater levels should be measured in accordance with procedures and protocols described in EII 10.2 (WHC 1988). All observations, water levels, well depths, and other measurements will be obtained using a pre-determined reference point and will be recorded in the field notebook. Groundwater level measurements will be compared with previous measurements from the same well for consistency. If the measurements differ by more than 0.15 m (0.5 ft), depth to groundwater will be remeasured for verification. Necessary repairs and concerns associated with the condition of the well will also be identified and recorded in a field notebook.

5.1.3.2.7 Aquifer Testing. The proposed approach for aquifer testing outlined in Table 5-3 includes both single well tests and slug and pumping tests with observation wells. As an initial strategy, the single well pumping

tests are planned to be completed for the aquifers identified during installation of the proposed well clusters listed in Table 5-3. Single well slug tests should be performed first, followed by pumping tests for applicable hydrostratigraphic units. A step drawdown test will be required to determine the optimal pumping rate for the longer term (constant discharge/recovery) pumping tests.

Slug interference and pumping tests with observation wells must be staged to use observation wells with temporary screens in the hydrostratigraphic unit being tested. Following completion of testing, the observation well would continue to be advanced to its target final completion depth. An example is the slug interference test proposed for Well UP1-3 (deep unconfined portion of the uppermost aquifer). This test should use a temporary screen for Well UP1-4 for an observation well in the same hydrostratigraphic unit as Well UP1-3 is being advanced to its target final completion depth in the Ringold Unit A gravels (confined aquifer). The projected final screen depths for the proposed testing wells are listed in Table 5-4.

Specific details regarding the staging of drilling for this testing program, and other details such as well diameter and screen design specification data, pump types, and other logistical constraints should be provided in follow-on DOW documents for aquifer testing. Testing will also be conducted in accordance with procedures and protocol described for slug tests and constant discharge/recovery tests in EII 10.1 (WHC 1988). The DOW testing plans should include contingency arrangements for containing, testing, and disposing contaminated discharge water during pumping tests, if encountered.

5.1.3.2.8 Air Sampling. There are four high-volume air samplers stationed within the 200-UP-1 Groundwater Operable Unit. The samplers contain filters, which collect particles entrained in the air. The sample filters are exchanged weekly and saved to be analyzed quarterly. The air sampling effort is an on-going activity that is independent of the other activities described in this work plan. However, during the field work at the 200-UP-1 Groundwater Operable Unit the air sampling results will be monitored more closely to see if the other field activities are impacting air quality. This monitoring will involve reviewing the data that are being generated by the on-going program to see if field operations have in any way impacted the local air quality. Air sampling will also be performed for carbon tetrachloride and other VOCs during the drilling process called for in drilling DOWs.

5.1.3.3 Laboratory Analysis. Vadose and saturated zone soil samples and groundwater samples will be submitted for chemical and radionuclide analysis, as discussed in Sections 5.1.3.1.2 and 5.1.3.1.4. Vadose and saturated zone soil samples will be sent to the laboratory for physical analyses as discussed in Section 5.1.3.3.2.

5.1.3.3.1 Chemical and Radionuclide Analyses. Table QAPJP-1 (Appendix A) lists the target analytes for the 200-UP-1 Groundwater Operable Unit and specifies the method of analysis. Chemical and radionuclide analyses will include the following for soil and water:

- Volatile organics

- Semivolatile organics
- Inorganics
- Radionuclides
- Common ions, alkalinity, total organic carbon (TOC), total dissolved solid (TDS), total suspended solid (TSS) (water only).

For soil, these analyses are recommended for the early "Palouse" soils, Plio-Pleistocene Unit, just above the water table, and from the depth of the screen interval for each well. If either unexpected soil contamination or perched water is encountered during drilling, then the supervising field engineer/scientist can decide to collect unscheduled samples for analysis. For groundwater, these analyses will vary according to well, as indicated in Table 5-2.

Detection levels for groundwater analyses will follow method standards for the analyses indicated in the QAPjP except where MCL and 4% DCGs and the QRA require lower levels. Detection limits necessary to support the QRA are shown in Table 5-5 and are derived based on a target 1E-6 risk level and groundwater ingestion. Where possible, analytical methods will be selected to meet these DQOs. In order to satisfy some of these requirements, the Low-level Contract Laboratory Program (CLP) Statements of Work (SOWs) for both organics (volatiles) and inorganics will be followed.

5.1.3.3.2 Physical Analyses. Three suites of proposed analyses (labeled as Type A to Type C) are identified below to distinguish between analyses appropriate for each hydrostratigraphic unit. A summary of the type of analyses selected for each unit is presented in Table 5-6. The recommended types of analyses and approximate depths where they should be collected are shown on schematic well diagrams on Figures 5-1 through 5-8.

Type A analyses will include the following:

- Moisture content
- Soil pH/Eh
- CaCO_3 content.

The Type A analyses are recommended for the early "Palouse" soils, Plio-Pleistocene Unit, and unsaturated portions of the Ringold Unit E gravels.

Type B analyses will include the following:

- Grain and cement mineralogy
- Bulk density
- Particle size distribution
- Porosity
- Soil pH/Eh
- Cation exchange capacity
- CaCO_3 content
- Organic carbon content.

An initial use of the borehole geologic data will be to verify that the anticipated screen intervals for well installations listed in Table 5-4 are acceptable. It is expected that many of the screen horizons may be adjusted slightly based on the local stratigraphy.

On a broader scale, the information will be used to further evaluate the lateral extent and thicknesses of geologic and hydrostratigraphic units presented on Figure 2-1. A key feature of this evaluation is the determination of the thickness and hydrologic properties of the Ringold lower mud unit and Ringold Unit A gravels at the locations of deep wells UP1-4/5, UP1-8, and UP1-11. This information is an important factor affecting the interpretation of aquifer testing data from the confined zones.

Additional data from vadose zone soil samples are expected to provide more-detailed delineation of the lateral thickness variability for the Plio-Pleistocene unit, early "Palouse" soil, and finer grained zones of the Hanford formation (potential perching layers). The vadose zone data will be useful for conducting of source area environmental assessment, evaluating potential future contributions to groundwater contamination, and developing and remediation work plans.

Information on subsurface conditions will be obtained from the geologist logs, grab samples, split-spoon samples, or core samples as specified in individual DOWs.

5.1.4.2 Aquifer Properties and Groundwater Flow Characterization. Aquifer properties will be evaluated through samples collected during borings, geophysical surveys, and aquifer tests proposed for the work plan. Soil samples will provide detailed lithologic information, and soil testing will quantify many of the soil characteristics needed for a complete hydrogeologic evaluation. Geophysical surveys will help refine stratigraphic interpretations.

Data from aquifer tests described in Section 5.1.3.1.7 will be analyzed using a variety of potential methods listed in Table 5-3. The analytical methods will be selected based on several criteria including:

- The overall quality and representativeness of the data obtained from the aquifer testing
- Appropriateness of the analytical method for hydrogeologic conditions encountered
- The intended application of data.

Aquifer testing data will be used to assess vertical anisotropy and possible leakage between the unconfined portion of the uppermost aquifer (Ringold Unit E), and the confined portion of the uppermost aquifer (Ringold Unit A). Water level elevation data obtained from 200-UP-1 Groundwater Operable Unit wells will allow for more detailed characterization of groundwater flow and horizontal/vertical hydraulic gradients. The data will also be used to assess possible perturbations in groundwater, flow and

gradients induced by changes in volume of effluent from 200 West Area discharge sources.

Aquifer test and water level elevation data obtained during proposed work plan field activities are also intended to support groundwater flow modeling activities. As an example, results of the aquifer test data analysis are useful for supplementing previous testing data from the unconfined portion of the uppermost aquifer (Ringold Unit E) described by Connolly et. al. (1992). The previous data were used to develop a hydrogeologic model of the unconfined aquifer for the 200 West Area, and were summarized in Section 3.5 of the *200 West Groundwater AAMSR*. Similar to the recommended 1993 shallow aquifer testing using existing operable unit wells (Section 4.2.1), results of proposed work plan aquifer testing should help support groundwater modeling studies by Westinghouse Hanford to evaluate remedial technologies related to the IRM.

An additional aspect of groundwater flow characterization is the identification of wells with potential to become dry due to falling water table elevations. As discussed in Section 5.3.1.1, wells in critical monitoring locations with potential for becoming stranded should be replaced with deeper installations if sampling is to be continued. To complete this evaluation, historic water table elevation records will be reviewed and extrapolated to predict locations where well screens will become stranded. The evaluation will use verified well screen and survey data.

5.1.4.3 Plume Delineation. Groundwater chemical data collected during the field sampling program discussed in Section 5.1.3.1.4.2 will be assessed to further delineate the extent of LFI constituent plumes (and LFI portions of IRM plumes) of concern in the 200-UP-1 Groundwater Operable Unit. The sampling program includes existing wells specified for each constituent, and new wells installed in areas that currently have sparse well coverage. As discussed in Section 5.1.3.1.4.2, the proposed locations and depths of the new wells were selected to provide data for assessing both the vertical and lateral extent of the constituent plumes.

A significant component of the plume delineation effort will involve comparison of the sampling data collected with existing groundwater chemical information. As part of this comparison, a detailed assessment of the overall quality of the historical analytical data is planned to evaluate analytical quality control, differing sampling and analytical methods, detection limits, and verification of "single detections." Other factors such as the potential influence of well construction materials on analytical results will also be considered (e.g., chromium contribution to groundwater from carbon steel well casings). The description of time variation trends of plume constituents in Section 3.1 (through April 1992) provides initial background information for the purposes of comparing changes in plume configurations over time.

5.1.4.4 Contaminant Characteristics and Transport. Another objective during the analysis of groundwater chemical data is to further assess contaminant transport characteristics. This assessment provides additional understanding of plume migration patterns over time, and information for operable unit remedial alternatives. Transport characterization is intended to primarily

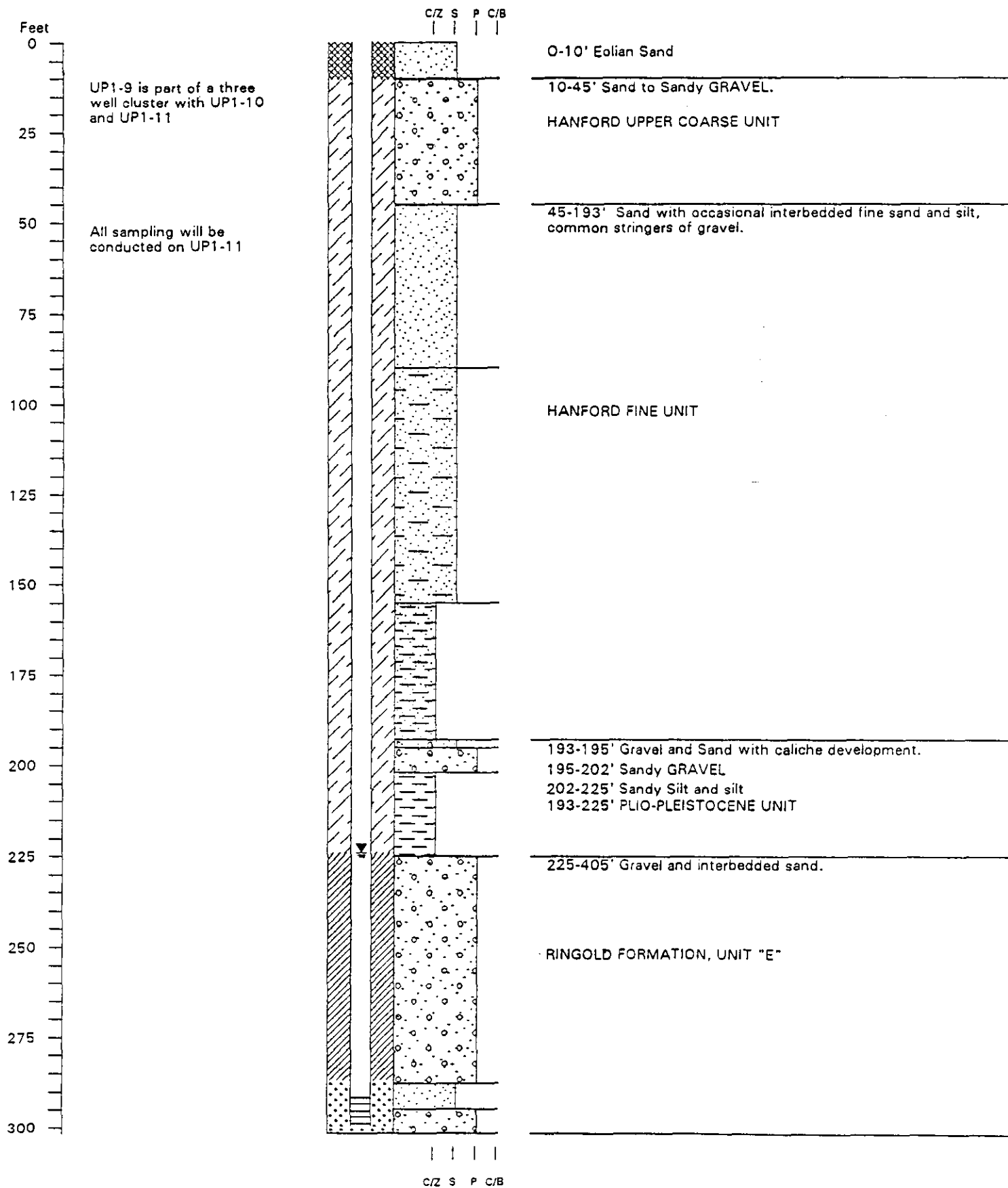
APPENDIX B

GEOLOGIC SAMPLING

APPENDIX B
GEOLOGIC SAMPLING

All stratigraphic information and sampling points are approximated; sample points are subject to the professional judgment of the site geologist.

UP1-9

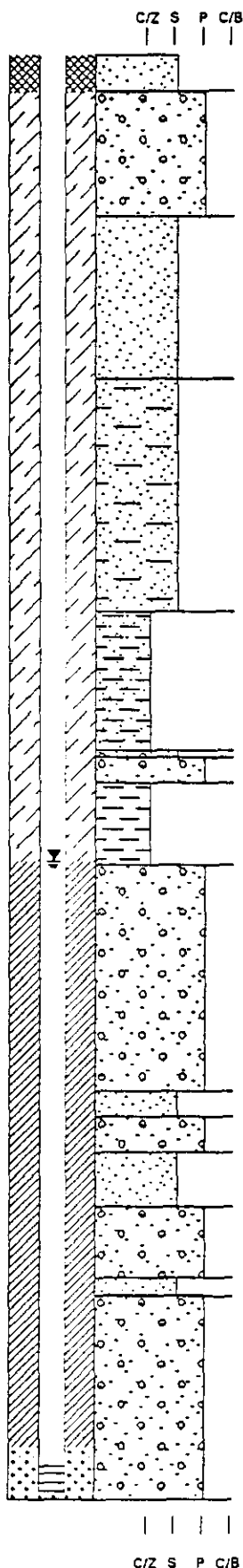


UP1-10

BHI-00138

Draft B

Feet
0
25
50
75
100
125
150
175
200
225
250
275
300
325
350
375
400



0-10' Eolian Sand

10-45' Sand to Sandy GRAVEL.

HANFORD UPPER COARSE UNIT

45-193' Sand with occasional interbedded fine sand and silt,
common stringers of gravel.

HANFORD FINE UNIT

193-195' Gravel and Sand with caliche development.

195-202' Sandy GRAVEL

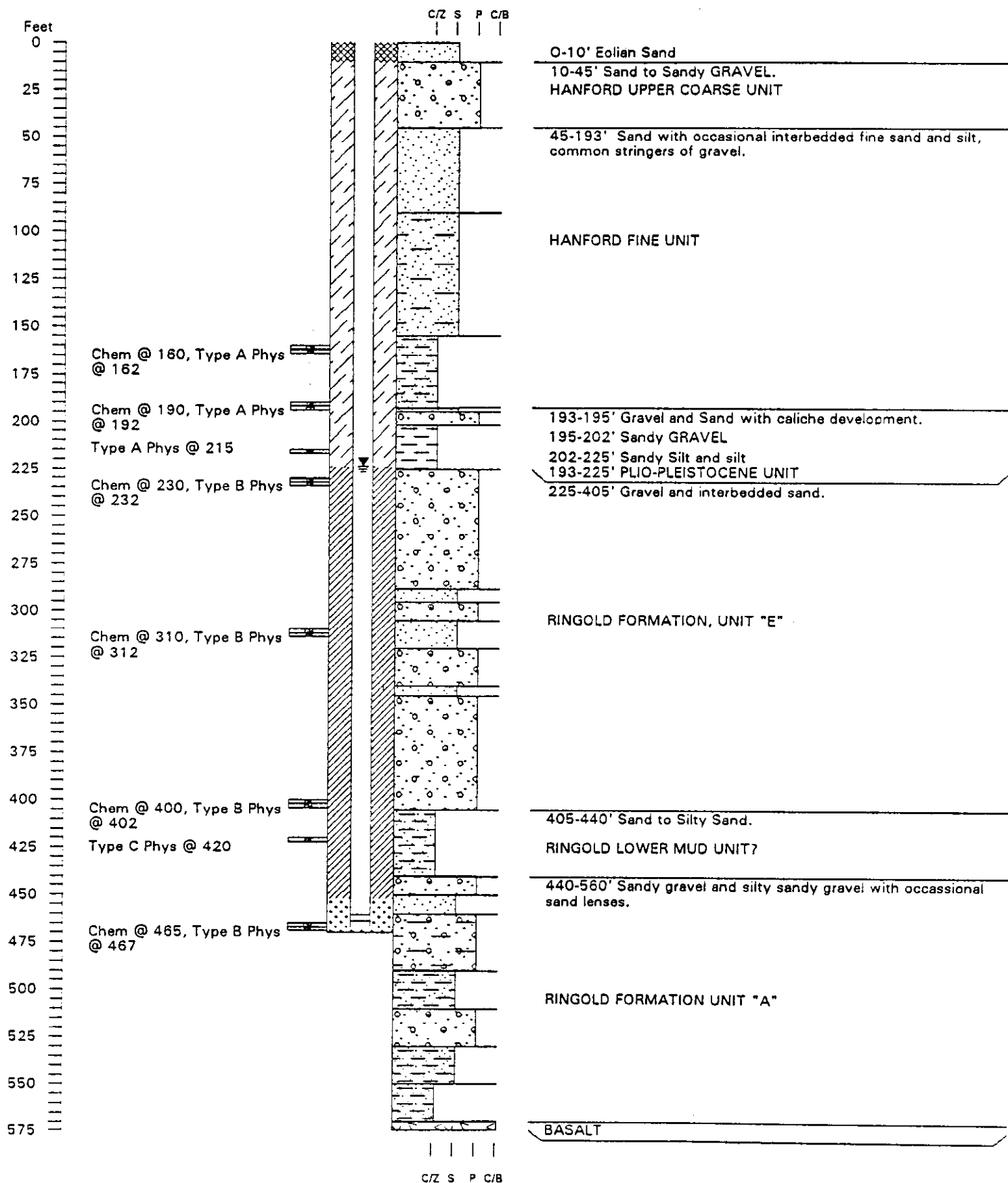
202-225' Sandy Silt and silt

193-225' PLIO-PLEISTOCENE UNIT

225-405' Gravel and interbedded sand.

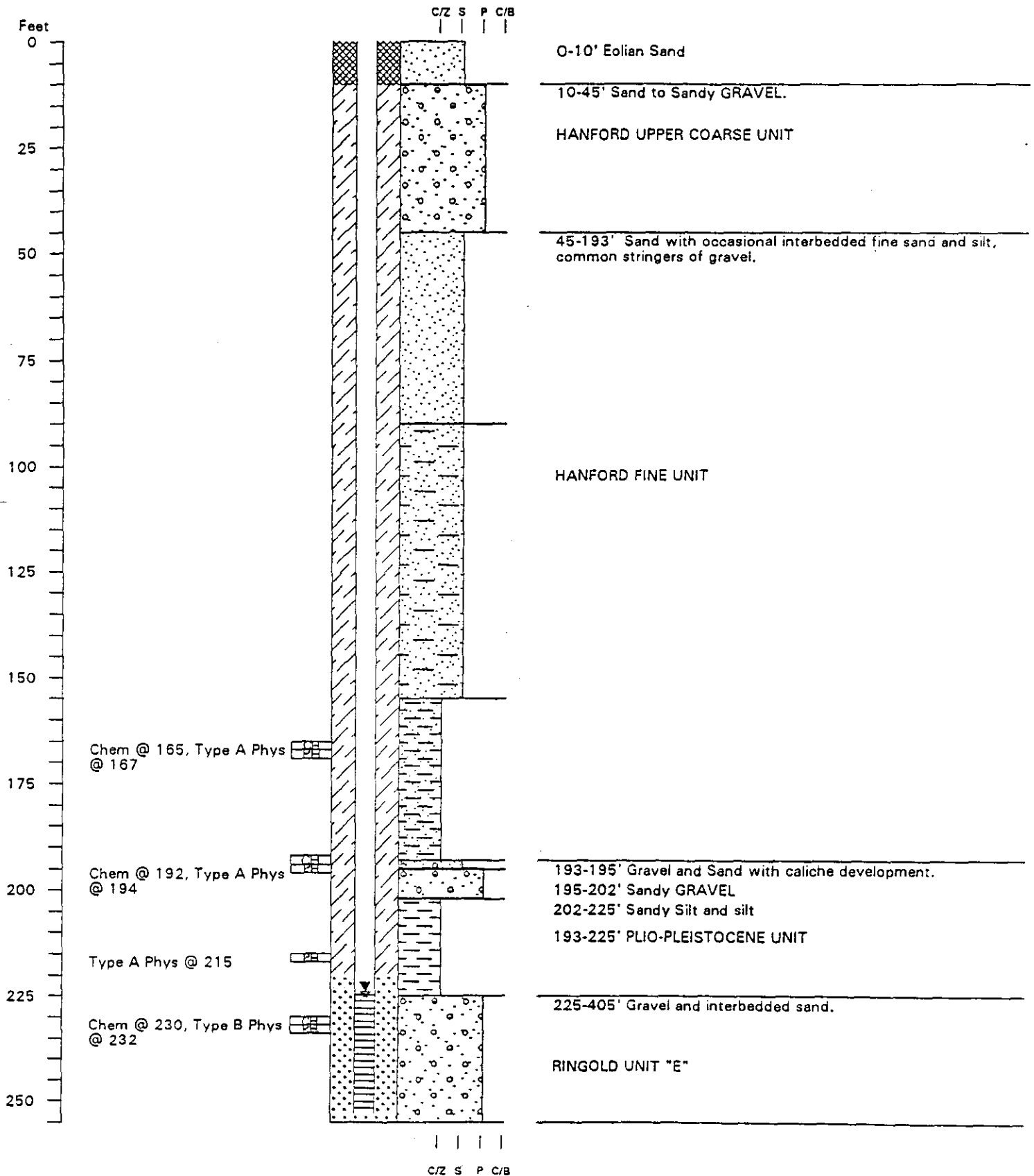
RINGOLD FORMATION, UNIT "E"

UP1-11



UP1-12

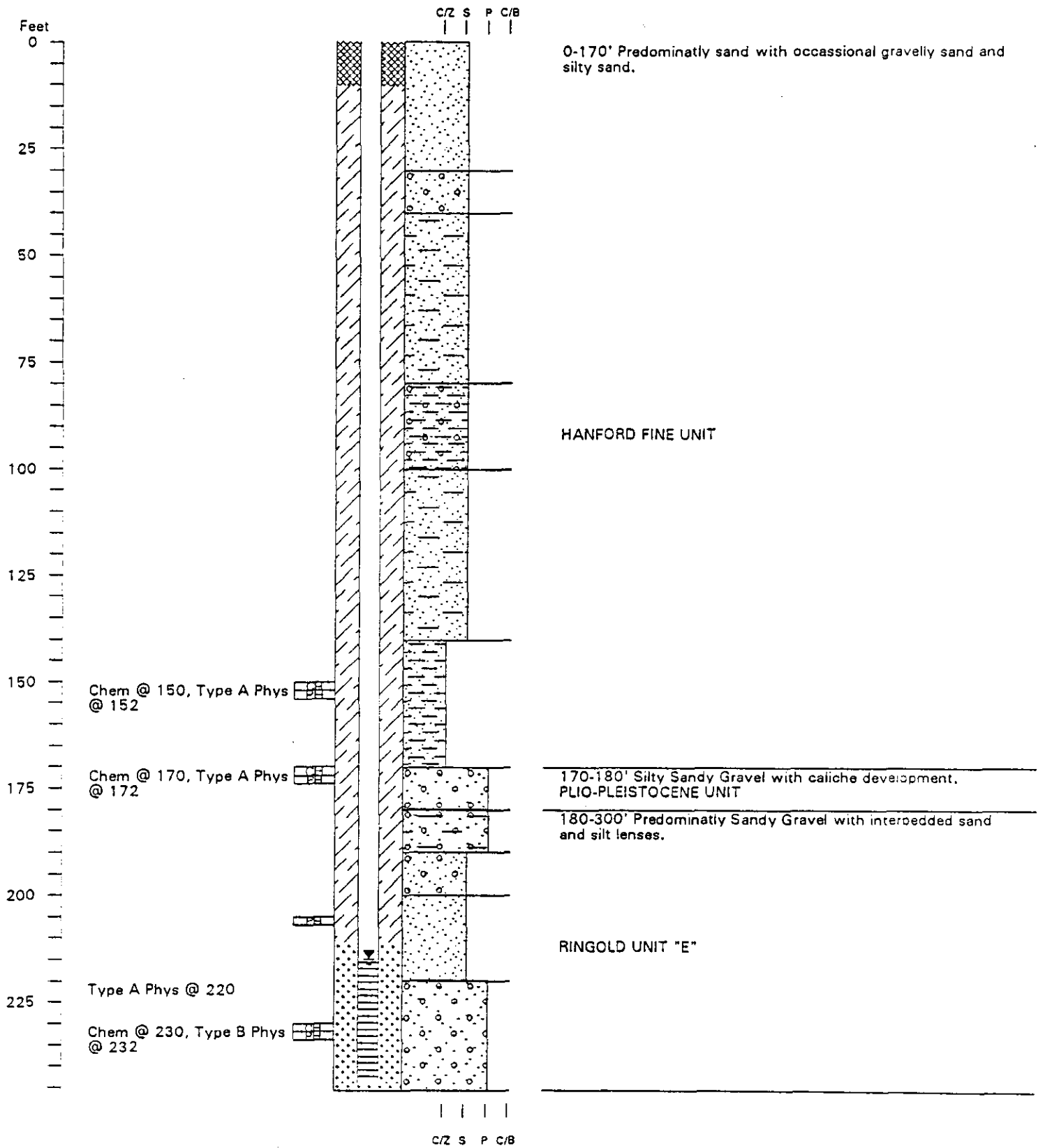
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Draft B



UP1-13

BHI-00138

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APPENDIX C

SLUG INTERFERENCE PROCEDURE

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SLUG INTERFERENCE PROCEDURE

PREREQUISITE:

1. Before installing any calibrated test equipment, verify and record that the equipment will remain in calibration over the period of the test.
2. Pretest monitoring of water levels at each well must start at least 1 day before the field testing begins to establish water-level trends (although a longer period is optimum). A barometric pressure transducer must be used to monitor atmospheric pressure changes over the same period of time. Both transducers must be set to the same recording rate and time (a maximum of 1-hour intervals).

PROCEDURE:

1. Install the observation well transducer within the screened interval of the well. Install and inflate an inflatable packer on a working string in the observation well as close as possible to the top of the well screen. The packer generally should not be seated inside the well screen, but may be if the screen is a louvered or bridge slot type. The packer must be set below the top of the water table.

NOTE: The test can still be conducted even if a packer is not set (e.g., testing a well with a wire wrap screen that transects the water table), although this is not the preferred method.
2. Begin baseline monitoring of water-levels and barometric pressures at the observation well(s) at 10-minute intervals.
3. Make up the wellhead assembly to the stress well.
4. Install two pressure transducers, one below the maximum depth that the water level will be depressed (but above the well screen), and the other above the static water level of the well. An electric tape will be placed above the lower transducer as a check to ensure that the water-level is not depressed into the well screen. Begin baseline monitoring using the transducer at 10-minute intervals.
5. Connect the gas line from the gas cylinder to the wellhead assembly and ensure the ball valves are closed. An inert type of gas such as nitrogen must be used.
6. Set the transducer recording rates to 1 minute for both the observation well and stress well. Ensure that the transducers in both the stress and observation wells are recording at the same rate and at the same time.

7. Pressure the well casing by opening the valve on the gas cylinder, thereby depressing the water level in the well to near the top of the well screen (maximizing the volume displaced), but not below the screen top. If the water level drops below the electric tape, the tape will no longer buzz when tested. This indicates that the water level has dropped into the screen, and the test must be abandoned (the test can be restarted after the water level restabilizes).
8. Hold the water level at this elevation until the transducers indicate the formation has restabilized (i.e., the pressure readings are relatively constant).
9. Reset the transducer recording rates to the most rapid recording rate (less than 1 second is preferred), and ensure that the transducers in the stress and observation wells are synchronized.
10. Open the ball valve on the wellhead assembly to instantaneously release the pressure in the casing, and monitor the water-level recovery in both the stress well and the observation wells until they return to static.
11. Repeat the process of pressurizing and depressurizing as many times as desired. At least two cycles are recommended. Tests may be repeated only after the water levels have restabilized.

VARIATIONS IN STRESS WELL CONFIGURATION:

1. If the stress well has a double-screen section, and the upper screen section will be tested, an inflatable packer on a working string must be installed in the blank casing section between the screens. Placement of the packer will isolate the two screen sections. The wellhead assembly is constructed to allow access to the lower screen section but still allow pressurization and depressurization of the upper screen interval (annular space).

Using this configuration, a third transducer should be installed through the working string to monitor water-level changes in the lower screen section. The recording rate and recording times must be synchronized with the transducer in the upper screen.

2. If in a double-screened well the lower screen section is to be tested, the same packer and transducer configuration can be used as for Variation 1, above. However, the working string is pressurized and then depressurized instead of the annular space.